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CHRIS RASCHKE
1964 - 2025

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Disappointment and déjà vu

WHEN Porsche confirmed it would withdraw its factory Hypercar programme from the World Endurance Championship at the end of 2025, the reaction across the paddock was a familiar mix of disappointment and déjà vu. Another giant of the sport heading for the exit.

But if history teaches us anything, it is that manufacturers have always come and gone. Porsche can't justify racing all over the world when it is cutting its workforce; Formula 1's finest were equally quick to flee when the financial crisis hit. The giants have dipped in and out of Formula E too, and sportscar racing has seen more ebb and flow than most care to remember. The badge on the nose changes; the underlying challenge does not.

For more than a century, motorsport has justified its existence as a crucible of innovation for the automotive world. Disc brakes forged at Le Mans, the rear-view mirror first used at the Indianapolis 500, turbo-hybrids, safety systems, materials science – the sport has earned its reputation for turning bold ideas into mainstream reality.

We need to be honest with ourselves, though: those era-defining breakthroughs are infrequent, and far harder to deliver at the sharp end of today's highly controlled rulebooks and risk-averse corporate cultures.

If our industry is to survive the peaks and troughs of economic cycles, shifting mobility priorities and political scrutiny, we must broaden our sense of relevance. Crucially, the value of motorsport technology goes beyond the car industry. Whether it's electrification, advanced simulation, lightweight structures, energy systems, hydrogen propulsion or sustainable fuels, racing can influence sectors far wider than automotive alone. That is why initiatives in hydrogen-powered competition are so important: they show motorsport applying its problem-solving mindset to one of the great global challenges of the age.

Too often, especially in Formula 1, the competitive narrative has been consumed by aerodynamic obsession – brilliant engineering, yes, but conducted in a vacuum. The next chapter demands environmental credibility, financial sustainability and genuine knowledge transfer. Manufacturers will stay if motorsport helps them answer their real-world challenges. If it doesn't, they won't hesitate to head for the door.

Porsche's exit should not trigger panic, but perspective. Our sport must ensure it is not just racing for the road car of tomorrow, but racing for the world we all have to live in. If we get that right, the grid will always refill – and with purpose as well as horsepower. RT

Mark Skewis
EDITOR

H for Hydrogen? No, H for Houdini!

Extreme H transforms hydrogen fuel cell dream into reality – then opens door to hydrogen combustion. By **Mark Skewis**

HOW did they *do* that?

When the lights went out on the FIA Extreme H World Cup in Qiddiya, motorsport entered a new era. For the first time, hydrogen-powered cars competed head-to-head in an FIA-sanctioned world event – and crucially, they did so safely, competitively, and convincingly. What had seemed a distant dream just a few years ago was suddenly tangible reality. As founder Alejandro Agag put it, "In Extreme H, H stands for Hydrogen, but also Houdini – we don't know how we pulled this off!"

It was a typically theatrical Agag line, but it captured the scale of what had been achieved. The event in Saudi Arabia marked not only the debut of the world's first hydrogen racing car, the Spark-built Pioneer 25, but also the moment when four years of experimentation, regulation writing, and technical risk culminated in something that worked – and worked well.

From the outside, it looked like any other motorsport weekend. Cars rolled off the line, raced door-to-door, and survived the rough off-road terrain of the Tuwaiq Mountains. Yet behind the apparent normality was a system unlike anything that had ever raced before. "Sometimes it's hard to believe it because from outside it looks normal," Agag said. "You're watching something with completely new technology that has never been done before, that's what's really the big impact of this race."

The sense of vindication was unmistakable. Just as Formula E once had to convince the sceptics that electric cars could race without bursting into flames, Extreme H faced similar doubts – only this time, the stakes were higher. "Many people were afraid of electric cars blowing up or giving electric discharge or whatever myth," Agag said. "With hydrogen there's also a lot of myths – the car is going to crash or it's going to blow up. But we had rolls, we had crashes, yet you can see that hydrogen is perfectly safe."

For Agag and his team, safety was the starting point. Hydrogen's image problem, rooted in long-standing misconceptions, had to be dispelled before the concept could even reach a race venue. The World Cup did just that, not through simulations or controlled demos, but in real, competitive conditions. "There were no hydrogen races before," Agag said. "Our format was perfect for it. Because if you want to have a five-hour race, or even an hour and a half race with hydrogen, you need a truck, but our cars were the perfect size."

That "perfect size" refers to the compact, single-spec off-road platform developed for

Photos: FIA/Extreme H

ABOVE LEFT Escape artist: Extreme H founder Alejandro Agag admitted the event had "gone better than planned"

LEFT Qiddiya represented a watershed moment as Extreme H beat the World Endurance Championship to the introduction of hydrogen motorsport

Extreme H – the Pioneer 25. Built from the ground up by Spark Racing Technology, it represented more than two years of intensive engineering. The car uses hydrogen fuel cells to generate electricity onboard, feeding a familiar electric powertrain, but the packaging, cooling, and refuelling systems required a complete rethink.

"We're so proud of the car we've been developing over the last two years," said Extreme H Technical Director Mark Grain. "It was absolutely incredible sitting in Race Control watching the cars race so competitively and put on such a great show in front of the world. We've built an impressive racing car and are beyond happy with the results in its first outing."

Grain, who also oversaw the technical transition from Extreme E's electric vehicles, called it "a huge moment" in his career.

> *"With hydrogen there are a lot of myths"*

"The new hydrogen era has landed," he said. "We will always be the first to race with hydrogen – everyone else goes after us."

The success of the inaugural event quickly gave way to thoughts of what comes next. It has now been confirmed that Extreme H will continue to call Qiddiya home for the next five years under a new deal to host the FIA Extreme H World Cup. "We have a venue for five years, we signed a long-term contract with Qiddiya," said Agag. "We know what the future is, so we're good. We will have the World Cup here every year. We may do other events previous to this one, but this one will always be the 'Final of the World Cup.'"

That stability is crucial for a technology still finding its competitive footing. It allows Spark and Extreme H's partners — including Symbio, Vodafone Business, Siemens, Yokohama, and PIF — to refine systems rather than rebuild them each season. It also provides a regulatory runway for the FIA to evolve its hydrogen framework, something already in discussion.

Hydrogen combustion

Beyond that, Agag has not ruled out the introduction of hydrogen combustion engines alongside fuel cells in future events. "I think it could potentially replace it," he said. "We have to see where the market goes, because there are brands, big car brands, that are focusing on fuel cells. Maybe we have two races, maybe we equalise and we have both technologies racing. I think it's early days to know. But definitely, if it works, it should be here."

For now, though, the focus remains on what has been achieved rather than what's to come. The inaugural FIA Extreme H World Cup didn't just show hydrogen could work – it made it look effortless. "We gave Extreme E a new life as Extreme H and definitely this format is going to fly," said Agag. "We have all the experience from Extreme E and we've used it for this."

If electric racing once proved the seemingly impossible could be engineered into existence, hydrogen racing has now done the same — only with higher volatility, tighter tolerances, and an even greater need for trust in the technology. As Agag said with a grin, "H stands for Hydrogen, but also Houdini." In motorsport terms, the escape act is complete: hydrogen has made its great escape from the laboratory into the real world of racing. RT

Fuel cells deliver on debut

THE beating heart of Extreme H is Symbio's 75-kw hydrogen fuel cell, adapted for motorsport from the 'StackPack75' module utilised in other industries.

The unit entered the first event underpinned by extensive testing equivalent to three seasons of competition running. The impressive performance and reliability it demonstrated in Qiddiya therefore came as no surprise.

"Everything worked remarkably well, especially considering the harsh conditions of the racetrack," reported Symbio motorsport director Serge Grisin. "We made some minor software adjustments and fine-tuning to optimize the use of the fuel cell by professional drivers who push the limits, while maintaining the highest safety standards.

"Our hydrogen-electric fuel cell systems demonstrated during the championship what we already knew from testing: they are robust and reliable. Even in unpredictable and tough conditions, they perform flawlessly."

Grisin was involved in the early days of Formula E, and maintains that he was always convinced motorsport would play a strategic role in the hydrogen journey.

"When I look back to my first conversations with Alejandro Agag about hydrogen potential in motorsport, I'd say I was confident that his pioneering spirit – and that of his team – would make it happen one day," he said. "But seeing what has actually been achieved in such a short time — a full hydrogen racing competition taking place in the middle of the desert — is truly remarkable. I think the event represented a major milestone, not only for motorsport, but for the entire hydrogen industry." RT

BELOW The hydrogen fuel cell-powered Pioneer 25 unclothed

Getty Images/Red Bull Content Pool

ABOVE The ADUO concept is intended to avoid a sustained period of dominance by any one team

FIA introduces 'safety net' to protect F1 engine parity under 2026 rules

THE FIA has approved a new regulatory mechanism designed to prevent engine manufacturers from being stranded at the back under Formula 1's radically revised 2026 power unit regulations. The Additional Development and Upgrade Opportunities (ADUO) framework, ratified by the World Motor Sport Council, provides a controlled safety net for any manufacturer whose power unit falls significantly short of its rivals' performance – yet stops short of introducing a Balance of Performance system.

The 2026 power unit rules, which retain the 1.6-litre V6 turbo architecture but remove the MGU-H while doubling electrical power, represent the biggest shift in F1's hybrid era. With Audi joining the grid, Honda returning, and Ford entering through its partnership with Red Bull Powertrains, the FIA expects the opening seasons to bring divergent levels of competitiveness as each manufacturer interprets the complex energy-management and combustion-hybrid integration rules.

To avoid a repeat of 2014 – when Mercedes's early advantage in mastering hybrid technology locked in years of dominance – the FIA will continuously monitor internal combustion engine output. After Races 6, 12 and 18, any manufacturer more than 3% down on peak ICE power could be granted ADUO status, unlocking limited extra development opportunities: additional test-bench hours, homologation flexibility and cost-cap relief.

FIA single-seater director Nikolas Tombazis was keen to stress that ADUO is not an equalisation measure. "It is important to be clear – this is not Balance of Performance," he said. "In Formula 1 it will never happen that a car receives an artificial boost in performance, nor that it is slowed by adding weight or reducing power. That will never happen."

Where Balance of Performance systems used in categories like WEC directly alter lap time by adjusting weight or power, ADUO instead allows extra development scope. It gives a struggling manufacturer more freedom to improve its engine – but it does not restrict or penalise the frontrunners. The goal is to protect competition without undermining technical merit.

"We have to be realistic," said Tombazis. "Formula 1 is comparable to a series of marathons: if you are quicker in the first, you already start the second with an advantage. Cost control is essential for sustainability, but it also makes recovery harder. In the past, Honda could invest heavily to catch up – that's no longer possible. ADUO gives those behind a chance to close the gap within structured limits."

The FIA has also introduced cost-cap relief for power unit manufacturers facing serious reliability problems, which could otherwise cripple their programmes under the new financial restrictions. Both measures are designed to ensure the stability of the power unit field and protect the long-term commitment of new entrants.

Tombazis said the intent is to sustain healthy competition, not to interfere with it: "Not all the teams will be ready for 2026. Some will misunderstand something at the beginning and need to recover. This framework ensures those efforts remain possible without rewriting the rules of competition."

In essence, ADUO is designed to be a carefully drawn line between regulation and innovation – a safety net for engine manufacturers, not a handicap for success – as F1 moves into its most ambitious hybrid era yet. RT

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Porsche exit blow for WEC

IN a move that sends shockwaves through endurance racing, Porsche has axed its factory involvement in the FIA World Endurance Championship (WEC) Hypercar class.

The decision reflects mounting financial pressures on the iconic brand, including falling electric vehicle sales in key markets, new import tariffs in the United States, and a planned workforce reduction. In Germany, management has announced a 10% cut in jobs by 2029. Nevertheless, it has been outwardly critical of the WEC's Balance of Performance regulations this season.

It was particularly vocal after the Le Mans 24 Hours, where its best car ran a "perfect race" but was still unable to match a trio of Ferrari 499Ps that were beset by problems.

The blow to the WEC is substantial. Not in terms of overall numbers, for the grid is to be swelled by new entries from Genesis, McLaren and eventually Ford, but because Porsche has been one of the sport's defining manufacturers. the loss of a factory-backed Porsche Penske operation removes one of the benchmarks for performance, engineering and prestige.

Nor will it be lost on the WEC organisers that Porsche will continue to run in both the IMSA LMDh series – in which it retained its titles in the season finale at Road Atlanta – and in Formula E.

"Electrification remains a key pillar of Porsche's powertrain strategy, both on the road and on the racetrack," commented Thomas Laudenbach, head of Porsche Motorsport. "The development progress we've seen in the first 11 years of Formula E has been huge. Next year, the fourth generation of Formula E cars will arrive – the biggest step in performance yet, with more than 800 PS and lap times likely close to those of Formula 2. In short: there is a great deal of technological knowledge currently being gained in electric motorsport, and our electric sports cars for the road benefit from that. We do not want to diminish those gains in knowledge."

Although the loss of the works Porsche 963s leaves a huge hole, the exit is not being framed as permanent. Laudenbach has stressed that the door remains open for a factory return to WEC under different conditions. He pointed specifically to the possibility of a unification of top-class regulations – already under discussion – potentially aligning with a new era around 2030. RT

WHY PORSCHE WIELDED THE AXE
Page 58

Ferrari channels F1 tech into first all-electric road car

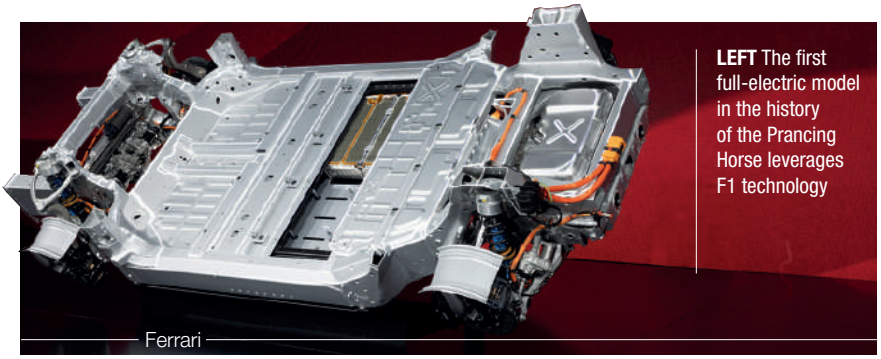
GREETED by one major newsroom's reaction 'Hell Freezes Over!', Ferrari has unveiled the production-ready chassis and powertrain components for its first all-electric model, the Elettrica. It describes the car as the culmination of a technology programme that began with the primitive Kinetic Energy Recovery System developed for its 2009 Formula 1 car.

Much of the new architecture draws directly on F1-derived systems, from the Halbach array rotors used in the compact, high-speed permanent magnet motors to the silicon carbide inverters and proprietary Ferrari Power Pack (FPP) control unit. Each of the two electric axles was designed entirely in-house at Maranello, using lessons from the Scuderia's energy recovery and electrical systems.

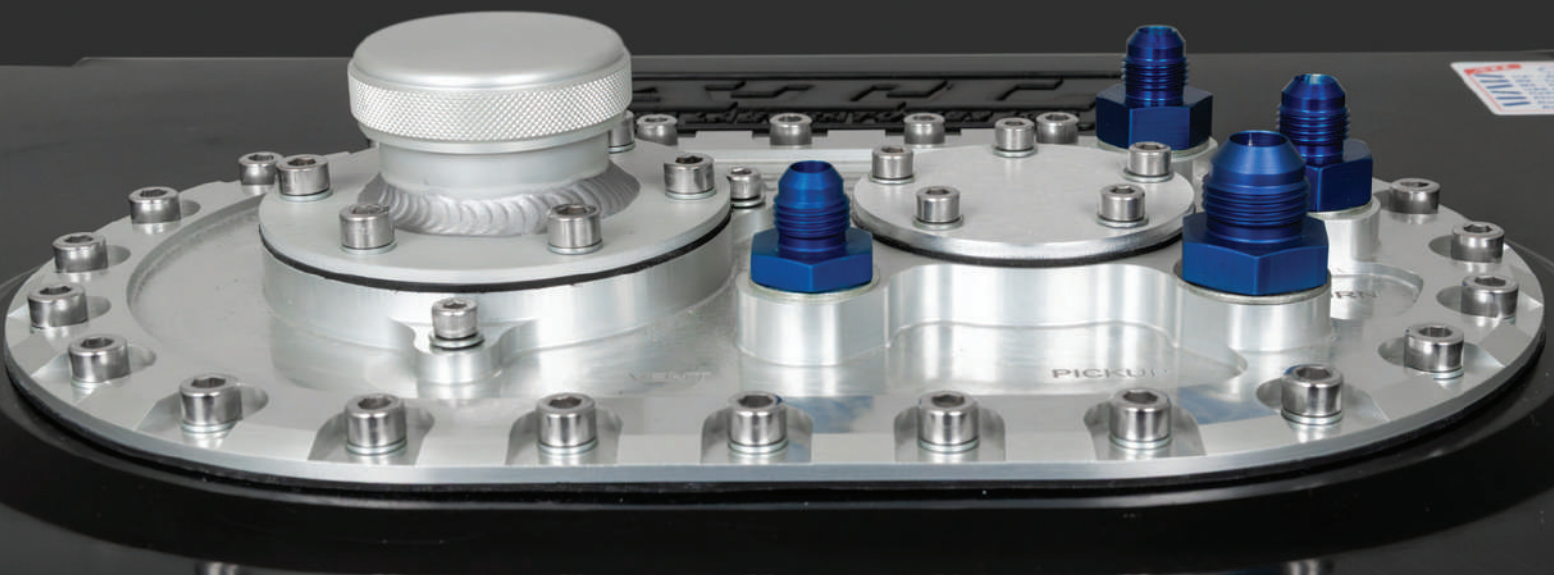
The front axle delivers 210 kW and integrates its 9 kg inverter directly into the housing for maximum efficiency, achieving 3.23 kW/kg power density at 93% efficiency. At the rear, Ferrari's engineers have reached 4.8 kW/kg, matching peak efficiency while delivering up to 8,000 Nm at the wheels. Both axles employ toggling – an F1-style switching strategy that pulses the inverter between on and standby states to optimise efficiency without dulling response.

The battery pack, built and assembled in-house, uses the chassis as a structural element to cut weight and improve stiffness. Its energy density of 195 Wh/kg and 800 V operating voltage puts it among the most power-dense packs in production. Positioned within the floorpan, it lowers the centre of gravity by 80 mm compared with an equivalent ICE model.

Ferrari's third-generation 48 V active suspension and new elasticised subframe complete the chassis package, balancing noise isolation with dynamic rigidity. With over 60 patented systems carried over or inspired by F1 practice, the Elettrica marks Ferrari's most direct translation yet of race-bred innovation into a roadgoing platform – one expected to define the next phase of its multi-energy strategy. RT


Ferrari

LEFT The first full-electric model in the history of the Prancing Horse leverages F1 technology



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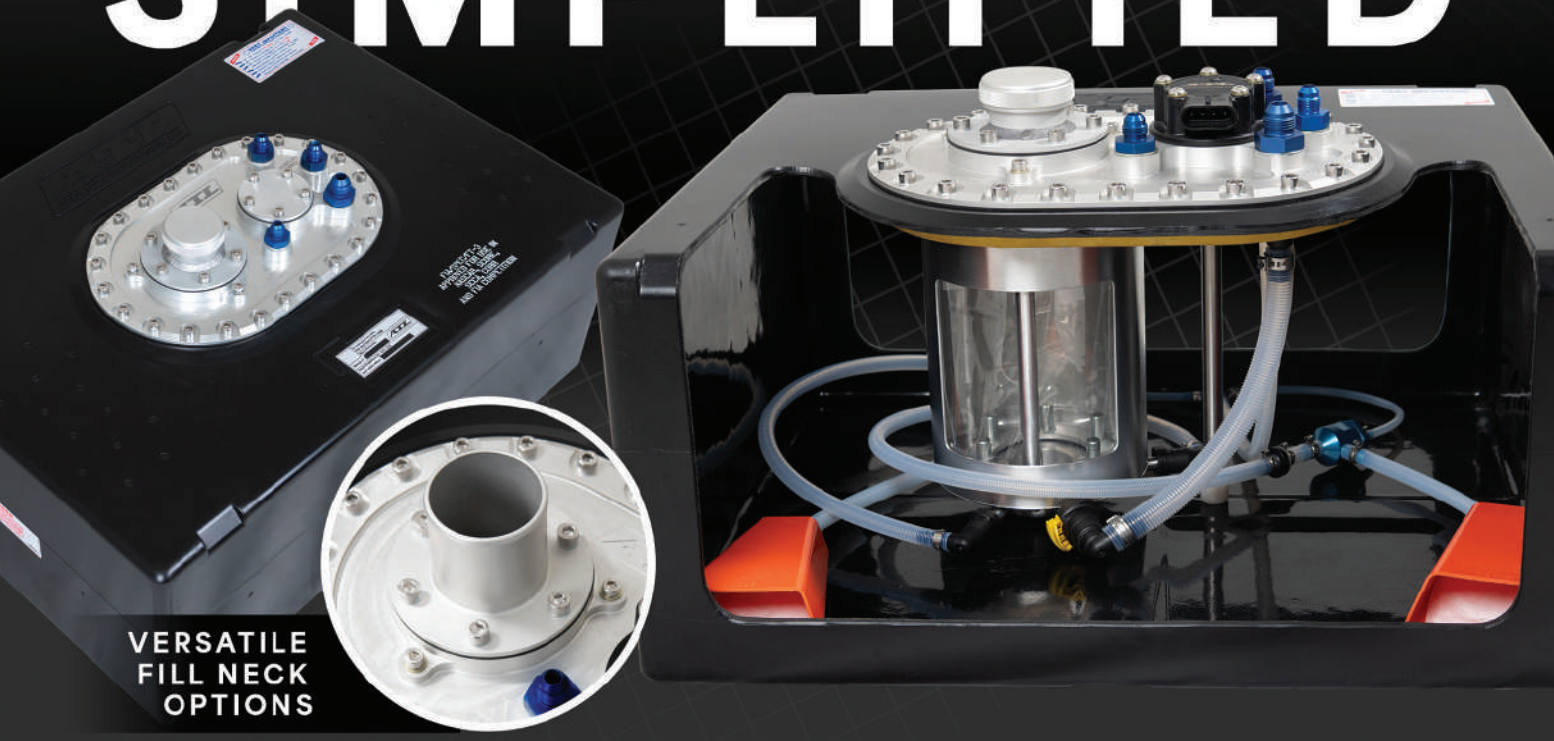

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Toyota pushes back against BoP with 2026 GR010 Hybrid update

TOYOTA will roll out the first major update to its GR010 Hybrid Le Mans Hypercar since 2023 for the start of the 2026 FIA World Endurance Championship, after a bruising 2025 campaign in which it has repeatedly voiced frustration over the Balance of Performance (BoP) system.

Despite being the most successful marque in WEC history, Toyota's challenge has faltered under a regime it believes has left the GR010 overweight and underpowered. Across the 2025 season, the car has run close to the maximum BoP weight of 1100 kg and near the minimum power output of 480 kW, a combination team principal Kamui Kobayashi said had "crippled outright pace".

ABOVE The GR010 is the oldest of the Hypercar prototypes

"We need to build a car that's crazy fast, and then have it adjusted by BoP," Kobayashi said after the Fuji 6 Hours, where Toyota finished a distant seventh. "Our target is to make a car so fast it can still win even with maximum weight and minimum power."

Vice-chairman Kazuki Nakajima confirmed that Toyota will introduce a new aerodynamic package – its first 'evo joker' update – aimed at improving top speed and efficiency. Homologation has taken place at the Windshear full-scale wind tunnel in North Carolina.

The revised GR010 features new front and rear bodywork to refine airflow and achieve a more consistent balance across a range of circuits. Toyota says the shape also aligns the prototype with its latest road-car design language, though the engineering intent remains clear: regain competitiveness at Le Mans, where it has not won since 2022.

"We've been made painfully aware of where we're lacking," said Nakajima. "Now the entire team is united in the goal of absolutely winning next year's race."

Defender Dakar D7X-R completes Sahara test as JLR confirms new motorsport head

DEFENDER Rally, JLR's newly formed rally-raid operation, has completed its first major test of the competition-spec Defender Dakar D7X-R in the Sahara Desert, marking a key step toward the brand's 2026 Dakar Rally debut.

The test took place around Erfoud in Morocco, a region long used by Dakar contenders for endurance work, where the team replicated rally-raid conditions with a cumulative mileage similar to a full Dakar event. The Defender Rally crew ran shorter dune loops before progressing to multi-hundred-mile stages that combined rough wadis, rocky plains, and faster sand tracks.

All three of the programme's headline drivers – Stéphane Peterhansel, Sara Price and Rokas Baciuška – took part in the running. The test was also the first public appearance for Ian James in his new capacity as team principal for Defender Rally. His appointment follows JLR's wider motorsport reorganisation, under which he also becomes managing director of JLR Motorsport and team principal of the Jaguar TCS Racing Formula E team.

"It's an honour to be leading the Defender Rally team as we enter the almighty world of rally-raid competition in 2026," said James, who was one of the architects of Mercedes' Formula E success.

ABOVE The Dakar D7X-R blazes the trail for the new Stock category

He added that the Dakar Rally had long been "a big bucket-list item" for him personally, having grown up watching rallying as a child.

The D7X-R has been developed to compete in the new production-based 'stock' category of the FIA World Rally-Raid Championship. It retains the aluminium monocoque structure and driveline layout of the road-going Defender, including the eight-speed automatic transmission and permanent all-wheel-drive system, paired with the same 4.4-litre twin-turbo V8 engine used in the Defender OCTA.

Beneath the familiar silhouette, the D7X-R features revised cooling and suspension geometry for long-travel compliance, heavy-duty underbody protection, and a fully integrated FIA-spec roll-cage. The car's software calibration, torque distribution and adaptive damping have all been re-engineered for sustained high-load operation on sand and rock.

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MIA celebrates 2025 Business Excellence Award winners

THE Motorsport Industry Association (MIA) has announced the winners of its 2025 Business Excellence Awards, recognising standout achievements across seven categories of the UK's motorsport and high-performance engineering sectors.

The awards were presented during the MIA's annual dinner at Silverstone's Wing, marking the close of the opening day of the Motorsport Engineering & Technology Show (CTS).

The Service to the Industry Award, partnered by Goodridge, went to the British Touring Car Championship (BTCC) – honoured for its enduring appeal and status as the UK's largest racing championship since 1958.

MGI Engineering claimed the New Markets Award (partnered by Fortescue Zero) for expanding its expertise in lightweight structures, propulsion and autonomous systems into aerospace, defence and sustainable mobility.

The Export Achievement Award, backed by Lifeline Fire & Safety Systems, was presented to Halo by Orthene for the rapid global success of its Halo P1 racing brake fluid, which powered Chip Ganassi Racing's Alex Palou to Indy 500 victory and the IndyCar title.

Toyota GAZOO Racing received the Technology & Innovation Award, partnered by Ricardo, for advancing hydrogen internal combustion (H2 ICE) powertrain development through its GR Corolla and GR LH2 Racing Concept programmes.

The Teamwork Award, partnered by Ridge, went to the McLaren Formula 1 Team, recognised for back-to-back Constructors' Championships under the leadership of Zak Brown and Andrea Stella.

In the Business of the Year (under £5 million) category, DC Electronics was honoured for its expansion into global electric power steering systems. "Our EPAS offering has expanded significantly over the last year, and our focus on optimising the range keeps us at the forefront of what we do," said Managing Director David Cunliffe.

The Business of the Year (over £5 million) award, partnered by Xtrac, was presented to Formula E, celebrating its milestone of 500 million cumulative viewers and renewed FIA partnership through 2048.

"The calibre of the winners and nominees demonstrates the outstanding levels of excellence which our members reach year on year," said Chris Aylett, Chief Executive Officer, MIA. "Of course, success in the competitive world of motorsport consistently demands such a high-quality performance from all involved."

LEFT The MIA's Business Excellence Award winners

Smiths HP and Luxfer MEL Technologies join forces ahead of 2026 F1 rules

SMITHS High Performance (Smiths HP) has announced an exclusive partnership with Luxfer MEL Technologies to accelerate the development of advanced magnesium alloy solutions for motorsport – with a strong focus on the next generation of Formula 1 regulations coming into force in 2026.

The collaboration brings together Smiths HP's expertise in high-performance metal supply and logistics with Luxfer's pioneering work in lightweight magnesium alloys. The two companies aim to provide teams and manufacturers with rapid access to advanced materials, technical support, and tailored supply solutions designed to meet stricter FIA weight and durability standards.

"Motorsport is about pushing boundaries – and materials play a critical role in performance," said Paul Garrett, Head of UK Sales at Smiths High Performance. "By partnering exclusively with Luxfer MEL Technologies, we can bring teams the very best in high-performance magnesium, delivered with the speed, precision and technical backup they demand. With the 2026 F1 regulations reshaping the grid, this partnership positions us to help teams adapt quickly and stay competitive."

ABOVE The alliance will drive the development of advanced magnesium alloy materials

Luxfer MEL Technologies' automotive and magnesium sector manager, Rick Tonge, added: "Our innovative magnesium technologies deliver up to 33% weight savings over aluminium, unlocking significant performance advantages in motorsport where every gram counts. Reduced mass means improved acceleration, handling and efficiency – giving teams a true competitive edge."

The partnership will span a wide range of motorsport applications, from powertrain components to structural elements, as teams look to optimise weight and strength in line with the 2026 technical framework. Beyond Formula 1, the companies also plan to extend their joint magnesium innovation into other high-level racing series and performance engineering sectors.

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Ansible Motion debuts Theta Cube Sport DIL simulator

ANSIBLE Motion has launched the Theta Cube Sport – a compact, enclosed Driver-in-the-Loop (DIL) simulator engineered to deliver full engineering-class functionality within a transportable 2.5 m^3 package. The system forms part of the company's new Sport product line, spanning its Delta, Sigma and Theta simulator series, and has already been deployed to a customer in Formula E.

Developed and built at Ansible Motion's Hethel, UK, facility, the Theta Cube Sport integrates computational and mechanical systems typically reserved for larger installations. It supports seamless connectivity with Software-in-the-Loop (SIL) and Hardware-in-the-Loop (HIL) environments, enabling closed-loop testing of control systems and vehicle models.

"Theta Cube Sport is a leap forward for compact, transportable motorsport simulators," said managing director Dan Clark. "It delivers an engineering-class DIL experience in a lightweight, fully enclosed form factor that's quick to install and operate."

The simulator's plinth-based cassette design provides cross-compatibility with other Ansible Motion Sport platforms, while its reconfigurable cockpit incorporates adjustable race seating, steering, and pedal systems. Steering forces are delivered through the company's Hand Wheel Loading System (AML HWLS), complemented by the High Frequency Actuator (AML HFA) array for tactile feedback, and optional Seat Belt and Helmet Loading Systems to cue longitudinal and lateral accelerations.

A 180-degree projection system, powered by NVIDIA RTX 4090 image generation and rFpro rendering tools, provides real-time visuals with zero latency claimed, while integrated audio and data systems complete the sensory environment. Ansible Motion's compact Data Acquisition Unit (AML DAQ) and Distributed Data Bus (AML DDB) deliver synchronous co-simulation, multi-channel analogue/digital I/O, and compatibility with external data logging or analysis suites.

Weighing just 800 kg and requiring only four single-phase power connections, the Theta Cube Sport offers a fully enclosed, transportable, and future-proof bridge between static and dynamic DIL simulators – allowing teams to run high-fidelity development programmes wherever required. RT

BELOW The Theta Cube Sport targets engineering-class DIL simulation in a compact package

Dynisma DMG-1 accelerates McLaren W1 virtual development

DYNISMA'S latest high-fidelity simulator has become a key tool in McLaren Automotive's virtual vehicle development, with a DMG-1 system now installed at the McLaren Technology Centre in Woking.

The partnership makes Dynisma McLaren Automotive's Official Motion Simulator Partner, bringing Formula 1-grade motion technology to its road car programmes. The DMG-1 delivers ultra-low latency and high bandwidth response, allowing engineers to reproduce the precise feel of suspension, steering and tyre behaviour with exceptional accuracy.

McLaren has already used the system extensively in the development of its forthcoming McLaren W1 supercar. The simulator was integral to validating active aerodynamic systems, damper control strategies and suspension interaction, correlating closely with results from physical testing.

"The accuracy and representativeness of the Dynisma Motion Simulator allows us to extract a new level of detail and data from virtual development," said Emmanuele Raveglia, McLaren's Chief Vehicle Programme Officer. "The fidelity of road texture and ride inputs is so precise that we can replicate standard road conditions and high-load circuit scenarios with remarkable realism."

ABOVE McLaren Automotive is using Dynisma's motorsport-derived technology

By closing the loop between CFD analysis, wind tunnel mapping, simulator trials and on-track validation, McLaren engineers can now complete a larger proportion of development virtually before committing to prototype builds. The approach reduces cost, time and environmental impact while maintaining the brand's focus on driver engagement and performance.

Dynisma founder and CTO Ash Warne said the installation "marks a milestone for McLaren's future automotive development," enabling the manufacturer "to replicate reality with exceptional precision and accelerate innovation."

The DMG-1's role in the W1 programme highlights how simulation fidelity is redefining the boundaries of road car development – and tightening the link between McLaren's track and road technology. RT

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THE DAVOS OF MOTORSPORT

Monday 17th – Tuesday 18th November 2025

THE FUTURE OF MOTORSPORT *IS IT SUSTAINABLE?*

PASCAL VASSELON
Vice President TGR Strategic Motorsport Development, Toyota Gazoo Racing

"The WMS has become a yearly 'Must Attend' event. The now-usual presence of many motorsport leaders, and especially of the governing bodies, make the discussions go beyond just interest: they can really influence the future of our sport. It is now more important than ever to call upon the brightest minds there to design a path toward the necessary energy transition. Long life to the WMS!"

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Consultant, Cadillac Formula Racing

THE SPEAKER

JOHN ILEY
Founder and Director, Iley Design Limited

- Sustainable Fuels and Hydrogen
- Artificial Inteligence
- Is the future still green?
- Business in Motorsport/Sponsorship
- Aerodynamics
- Women in Motorsport
- Future of Motorsport
- Chassis
- The future direction of Powertrain

THE CABINET MEMBERS & SPEAKERS (Confirmed to date)

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Executive Vice President - Multimatic Special Vehicle Operations Group Multimatic Engineering

JASON SOMERVILLE
Head of Aerodynamics, Fédération Internationale de l'Automobile FIA

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CEng, Founder and Chief Executive Officer, Enovation Consulting

SIMON DODMAN
Chief Engineer, Aerodynamics, Cadillac Formula 1 Team

JOHN COOPER
Metavasi Strategies Limited, Director, Consultant

DAY ONE: Monday 17th November 2025

- 8.30 – 8.55
  Registration and Coffee
- 8.55 – 9.00
  Opening and Welcome by Soheila Kimberley
  Publishing Director, RACE TECH Magazine
- 9.00 – 9.05
  Welcome by Duncan Wiltshire
  Chairman, Royal Automobile Club
- 9.05 – 9.10
  Welcome to the World Motorsport Symposium by the Chairmen
  Ulrich Baretzky, Former Director Audi Motorsport Engine Development, Audi AG
  Pat Symonds, Executive Consultant, Cadillac Formula 1 Team

SUSTAINABLE FUELS AND HYDROGEN

- 9.10 – 9.20
  Presentation and Q&A by John Cooper
  Director, Metavasi Strategies Limited
  "Sustainable Fuels for Motorsport and Road Transport – An Outlook"
- 9.20 – 9.30
  Presentation and Q&A by Mark Grain
  Technical Director, ExtremeH
  ExtremeH, The Worlds First FiA Hydrogen World Cup
- 9.30 – 10.15
  Panel session inc Q&A: *Sustainable Fuels and Hydrogen*
  John Cooper, Director Metavasi Strategies Limited
  Mark Grain, Technical Director, ExtremeH
  Pascal Vasselon, Vice President, Toyota Gazoo Racing Europe
  Charlie Minors, Director of Strategy, F1
  Andrew Bergbaum, Global Co-Leader Automotive & Industrials Practice, AlixPartners
  Jeff Dodds, CEO, Formula E
- 10.15 – 10.45 **COFFEE BREAK**

FUTURE OF MOTORSPORT

- 10.45 – 10.55
  Presentation and Q&A by Dr Cristiana Pace
  Founder and CEO, Enovation Consulting
- 10.55 – 11.05
  Presentation and Q&A by Jeff Dodds
  CEO, Formula E, 'What is the future of electric racing?'
- 11.05 – 11.50
  Panel session inc Q&A: *Future of Motorsport, is it sustainable?*
  Dr Cristiana Pace, Founder and CEO, Enovation Consulting
  Jeff Dodds, CEO, Formula E
  Darren Sansum, Managing Director of Engine Development, IndyCar
  Charlie Minors, Director of Strategy, F1
  David Salters, President, Honda Racing Corporation USA
  Dr. Frank-Steffen Walliser, CEO, Bentley
- 11.50 – 13.15 **LUNCH BREAK**

ARTIFICIAL INTELLIGENCE

- 13.15 – 13.25
  Presentation and Q&A by Dominic Harlow
  Deputy Technical Director, FIA
  The intersection of AI and Formula 1 Regulation at the FIA
- 13.25 – 13.35
  Presentation and Q&A by Simon Dodman
  Chief Engineer, Aerodynamics, Cadillac Formula 1 Team,
  Fusing Data and Flow: A Digital-Twin-Inspired Approach to Aerodynamic Testing
- 13.35 – 13.45
  Presentation and Q&A by David Wheater
  Technical Director Aerodynamics, PhysicsX
- 13.45 – 14.30
  Panel session inc Q&A: *Artificial Intelligence*
  Dominic Harlow, Deputy Technical Director, FIA
  Simon Dodman, Chief Engineer, Aerodynamics, Cadillac Formula 1 Team
  David Wheater, Technical Director Aerodynamics, PhysicsX
  Peter Lyu, Field CTO & VP of Solutions, Luminary Cloud
  Alan Patterson, CEO, BeyondMath
- 14.30 – 15.00
  Fireside chat
  Darren Sansum, Managing Director of Engine Development, IndyCar
  Tino Belli, Director of Aerodynamic Development, IndyCar
- 15.00 – 15.30 **COFFEE BREAK**

THE FUTURE DIRECTION OF POWERTRAIN

- 15.30 – 15.40
  Presentation and Q&A by Dr Frank-Steffen Walliser
  CEO, Bentley. "An OEM perspective on the future of Motorsport: Insights and outlook"
- 15.40 – 16.25
  Panel session inc Q&A: *The future direction of Powertrain*
  Dr Frank- Steffen Walliser, CEO, Bentley
  David Salters, President, Honda Racing Corporation USA
  Darren Sansum, Managing Director of Engine Development, IndyCar
  Larry Holt, Executive Vice President, Multimatic
  Pascal Vasselon, Vice President, Toyota Gazoo Racing Europe

CHASSIS

- 16.25 – 16.35
  Presentation and Q&A by Leena Gade
  Vehicle Dynamics Manager and Race Engineer, Multimatic
- 16.35 – 17.20
  Panel session inc Q&A: *Chassis*
  Leena Gade, Vehicle Dynamics Manager and Race Engineer, Multimatic
  Adrian Moore, CEO, Xtrac
  Douglas Campling, General Manager – Motorsport, Fortescue Zero
  Pascal Vasselon, Vice President, Toyota Gazoo Racing Europe
- 17.20 – 17.30
  Resume of the day
  Wrap-up from **Ulrich Baretzky & Pat Symonds** on conclusions from both morning and afternoon sessions

DAY TWO: Tuesday 18th November 2025

- 8.30 – 9.00
  Registration and Coffee
- 9.00 – 9.05
  Opening and Welcome by Soheila Kimberley
  Publishing Director, RACE TECH Magazine
- 9.05 – 9.10
  Welcome to day two of the World Motorsport Symposium by the Chairmen
  Ulrich Baretzky, Former Director Audi Motorsport Engine Development, Audi AG
  Pat Symonds, Executive Consultant, Cadillac Formula 1 Team

AERODYNAMICS

- 9.15 – 9.25
  Presentation and Q&A by Eric Jacuzzi
  Vice President, Vehicle Performance, NASCAR,
  NASCAR Aerodynamic Liftoff Prevention
- 9.25 – 9.35
  Presentation and Q&A by Jason Somerville Head of Aerodynamics, FIA and **William Stone**, Aerodynamicist, FIA.
  "Formula Regional Gen 2 - Development and Validation"
- 9.35 – 10.20
  Panel session inc Q&A: *Aerodynamics*
  Jason Somerville, Head of Aerodynamics, FIA
  Eric Jacuzzi, Vice President, Vehicle Performance, NASCAR
  Tino Belli, Director of Aerodynamics Development, IndyCar
  Simon Dodman, Chief Engineer, Aerodynamics, Cadillac Formula 1 Team
  John Iley, CEO, Iley Designs
  Willem Toet, F1 and Aerodynamics Specialist
- 10.20 – 10.50 **COFFEE BREAK**

IS THE FUTURE STILL GREEN?

- 10.50 – 11.00
  Presentation and Q&A by Andrew Bergbaum
  Global co-leader Automotive and Industries, Alix Partners
  The passenger vehicle powertrain puzzle and why that matters for motorsport
- 11.00 – 11.10
  Presentation and Q&A by Charlie Minors
  Director of Strategy, F1
- 11.10 – 11.55
  Panel session inc Q&A: *Is the future still green?*
  Andrew Bergbaum, Global co-leader Automotive and Industries, Alix Partners
  Charlie Minors, Director of Strategy, F1
  Pascal Zurlinden, Director of Performance Engineering at Multimatic Special Vehicle Operations
  Thomas Laudenbach, Vice President Motorsport, Porsche AG
  Dr Roland Sargenti, Director of Whole Vehicle Engineering, Bentley
  Mario Illien, Owner, Ilmor Eng
- 11.55 – 13.15 **LUNCH BREAK**

THE FUTURE DIRECTION OF POWERTRAIN

- 13.15 – 13.25
  Presentation and Q&A by David Salters
  President, Honda Racing Corporation USA
  "Future Direction of Powertrain"
- 13.25 – 13.35
  Presentation and Q&A by Mario Illien
  Owner, Ilmor Eng
- 13.35 – 14.20
  Panel session inc Q&A: *The future direction of Powertrain*
  David Salters, President, Honda Racing Corporation USA
  Mario Illien, Owner, Ilmor Eng
  Thomas Laudenbach, Vice President Motorsport, Porsche AG
  Dr Roland Sargenti, Director of Whole Vehicle Engineering, Bentley
  Darren Sansum, Managing Director of Engine Development, IndyCar
  Pascal Vasselon, Vice President, Toyota Gazoo Racing Europe
- 14.20 – 14.50 **COFFEE BREAK**

WOMEN IN MOTORSPORT

- 14.50 – 15.00
  Presentation and Q&A by Sian Wyles
  Principal Engineer – Motorsports Programmes, Fortescue Zero
- 15.00 – 15.10
  Presentation and Q&A by Nicole Bearne
  Director, Motorsport UK.
  Women in Motorsport: Creating Pathways
- 15.10 – 15.50
  Panel session inc Q&A: *Women in Motorsport*
  Sian Wyles, Principal Engineer – Motorsports Programmes, Fortescue Zero
  Nicole Bearne, Director, Motorsport UK
  Leena Gade, Vehicle Dynamics Manager and Race Engineer, Multimatic
  Abi Penny, Senior Lecturer, UWTSD
- 15.50 – 16.00
  Resume of the day
  Wrap-up from **Ulrich Baretzky & Pat Symonds** on conclusions from both morning and afternoon sessions

NB. The programme is subject to change

RACE TECH
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ELECTRIC DREAMS

Chris Pickering speaks to battery modelling specialist About:Energy about a study aimed at discovering whether Formula 1 could ever go fully electric

IT'S 11 years since Formula E brought electric racing into the mainstream. During that time, the cars have undergone perhaps the most impressive evolutionary process in modern motorsport, morphing into highly-optimised four-wheel drive racing machines capable of out-accelerating a Formula 1 car off the line.

And yet, over a full race distance, the combustion engine (with or without a hybrid system) remains untouchable. At Monaco, the Formula E lap times were 20 seconds off the Formula 1 pace, even with the front powertrains activated during qualifying. Come the race, the Formula 1 cars covered just over two and a half times the distance of their all-electric counterparts.

That much we knew already. But just how far off Formula 1 would electric technology be if the powertrain engineers were given free rein? And what might be plausible in the future? To find out, we enlisted the help of battery modelling specialist About:Energy.

"F1 is already an electrified sport. We're not necessarily suggesting that it will ever go fully electric, but with the 2026 regulations, the battery is becoming a much more important factor – both in terms of performance and sustainability. This has been a useful experiment to look at where the category needs to go if it wants to close that gap even further," comments company co-founder Kieran O'Regan.

For comparison, we're looking to the Hungaroring. Sometimes referred to as 'Monaco without the barriers' it has a tight, twisty layout that sits between a Formula E street circuit and a classic grand prix track in character. Crucially, we're going to assume that the performance of the current Formula 1 machines must be maintained, along with broadly the same race format.

Our study, carried out by About:Energy's battery simulation engineer Christian Pilling, uses publicly accessible telemetry data from Oscar Piastri's car in the 2024 Hungarian Grand Prix, taken from the FastF1 database.

First principles

Before delving into greater detail, Pilling begins with a hand calculation to establish the cell-level gravimetric power and energy densities that would theoretically be required for a battery pack to operate as a drop-in substitute for the current hybrid powertrain with no increase in mass. The results are stark, although not perhaps unexpected.

Taking a typical race fuel load of 100 kg and an energy density of 12 kWh/kg, he estimates the total energy held in the tank at 1,200 kWh. Given that the current F1 V6 has an efficiency of about 50 per cent, this puts the combustion powertrain energy output at 600 kWh. The ERS (Energy Recovery System) of an F1 car is allowed to output 1.11 kWh of energy per lap but regenerate only 0.55 kWh per lap. Over the course of an Hungarian Grand Prix with 70 laps, this puts the total powertrain energy output at 639 kWh.

Meanwhile, Pilling bases the Formula 1 car's power output on published figures for current powertrains, which indicate that F1 cars output up to 735 kW or 1,000 bhp in total, split roughly as 850 bhp from the engine and 160 bhp from the MGU-K.

The fuel load in an F1 car is very carefully optimised. So, for the purposes of this study, it's assumed that the entire 100 kg fuel mass will be consumed over the course of the race. Under the F1 regulations, the minimum powertrain mass is limited at 150 kg. Throwing in half a tank of fuel, gives an average powertrain mass (including fuel) of approximately 200 kg over the course of the race.

So how does this compare to an electric powertrain? "The most power dense axial flux motors we ▶

BELOW Could Formula 1 ever go all-electric? Current Formula 1 cars still cover far more ground than their fully electric counterparts from Formula E

Red Bull Content Pool

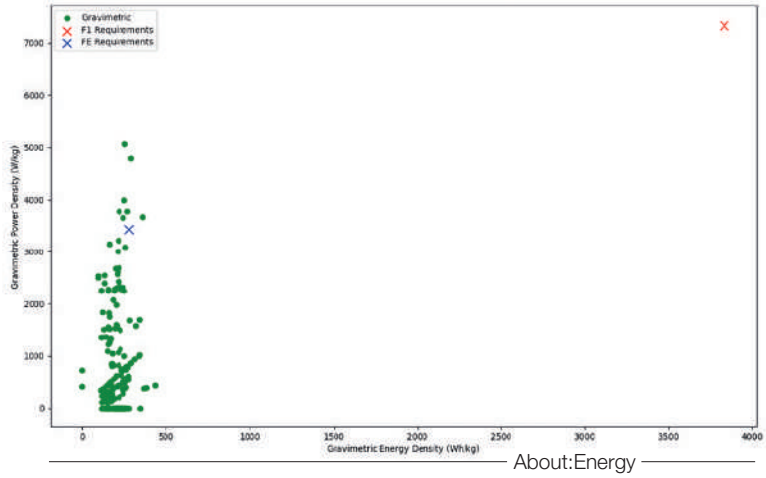
could find were developed by YASA and achieve power density of 42 kW/kg. Similarly, we took the 50 kW/kg power density for the SiC inverter used in the Koenigsegg Gemera hypercar as an indication of what's possible there. For our 735 kW power requirement, that gives us a motor weight of 17.5 kg and an inverter weight of 14.7 kg, both of which are just amazing, in my opinion. It shows how far motor and inverter technology have come. But that means we've used 32.2 kg of our weight allowance, so we only have around 168 kg left for the battery," comments Pilling.

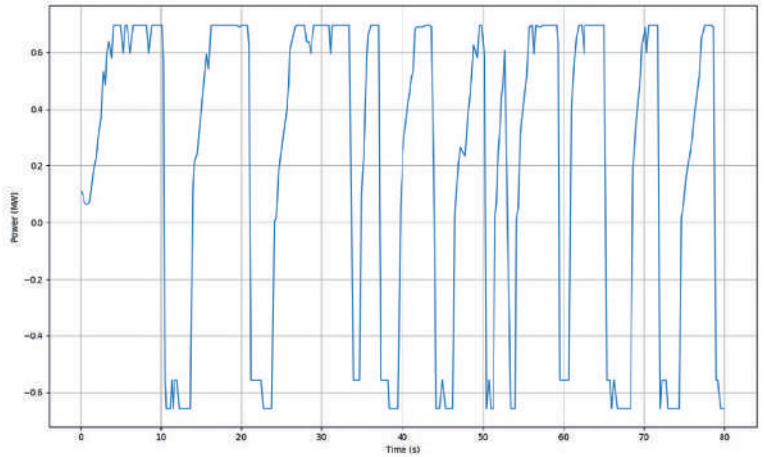
Energy issues

Typically, Pilling explains, the cells in a battery account for around 60 per cent of its total mass – the remainder coming from thermal management systems, cell-to-cell connections and other components. This leaves around 100 kg for the cells.

Immediately, we can see that this requires a power density from the cells of around 7.35 kW/kg. For the cell energy density, we still have to consider that the electric F1 car will have much greater ability to regenerate energy. Formula E cars can regenerate up to 40 per cent of their expended race energy. Pilling states that, considering the drag-heavy aero on F1 cars, he is being generous and assuming that the electric F1 car can also regenerate 40 per cent of its expended energy. This

> *"Over a full race distance, the combustion engine remains untouchable"*





About:Energy

BELOW This Ragone plot shows how Formula 1 energy density requirements (marked with a red cross) are way above current cell specifications whereas Formula E's needs are within the datasheet cell capabilities

BOTTOM This plot shows the power profile of Oscar Piastri's first lap of 70 in the 2024 Hungarian Grand Prix. MGU-K is deployed during its highest spikes whereas Regen power is applied when the ICE discharge power is 0

leads to a cell energy density of 3.834 kWh/kg. These figures are presented on a Ragone plot, which shows energy density against power density, and compared them to other cells in About:Energy's database.

"I was actually surprised by just how big the gap in energy density is," Pilling admits. "The power density was a pleasant surprise – there's quite a large gap, but it looks like it could be achievable with lithium-ion technology given the right cooling. On the other hand, there's no way lithium-ion technology can compete with the energy density of Formula 1 fuel of 12 kW/kg. The gap there is insurmountable."

To illustrate the scope of the problem, Pilling has also plotted the current Formula E cells. They sit towards the upper end of the current high-performance cells, but they are still nowhere near the energy density requirements for our hypothetical electric F1 car.

"We could just say 'this just isn't possible' and stop there, but we wanted to see what would happen if we loosened the requirements. For instance, what if we said we would accept an increase in mass?" he proposes.

It's worth acknowledging that there is still a massive gap between Formula 1 and Formula E. For all the progress that the electric series has seen in the past 11 years, the cars average around 80 mph across a race of 50 to 60 miles; even around the twists and turns of the Hungaroring, Piastri's winning drive in 2024 works out an average of 116 mph across 190 miles.

Of course, modern Formula 1 cars have more mechanical grip and vastly more downforce than a Formula E car, but with this comes extra rolling resistance and more aerodynamic drag. Nonetheless, there's plenty of middle ground that could be interpreted as either an alternative electric take on Formula 1 or a future incarnation of Formula E.

Power trace

In order to explore these options, Pilling and University of Bristol PhD student Amey Gupta – a Simulation Engineering Intern at About:Energy – begin by drawing up a profile of power usage against time for one of Piastri's laps around the Hungaroring. This involves a series of assumptions: There is no power trace that's publicly available, so they combine data for rpm and throttle opening against time, along with the maximum fuel flow rate (mandated in the rules) and the combustion engine's efficiency to infer one.

There's also no publicly available data on the exact deployment of the MGU-K power, so this was spread evenly over the power peaks (where the driver is on the throttle). Conversely, it was assumed that regen can be spread evenly across the troughs where the throttle is closed or the driver is on the brakes ▶

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About:Energy

ABOVE Analysing battery performance data with advanced modelling tools in the About:Energy lab

BELOW About:Energy's study uses publicly accessible telemetry data from Oscar Piastri's car (left) in the 2024 Hungarian Grand Prix, taken from the FastF1 database

– once again taking the generous Formula E figure of 40 per cent. Spread across the lap, this gives the energy coming back in during regen. Combined, they produce a power/time trace that ranges from negative power output (during regen) to positive (when the engine and/or ERS system is doing work). The total energy demand for this profile turned out to be 607 kWh, fairly close to our initial hand-calculation estimate.

"There are obviously some simplifications going on here," comments Pilling. "We assume, for instance, that the driver is braking whenever they're completely off the throttle. Of course, they could be coasting, but that's sometimes also used to regenerate, depending on how the system is set up. They could also be braking a little at the same time as using the throttle. But we're happy with these assumptions as they have more impact on the peak power; the main constraint we're interested in is the overall energy, which is fixed."

Alternative scenarios

This power trace was used to run About:Energy's proprietary model of the Molicell P50B – a cell that offers one of the best trade-offs between power density and energy density, according to Pilling. Three different scenarios were assessed using this model:

1. A battery pack that would maintain the current F1 car's weight.
2. A battery pack twice the size of that in Scenario 1 (increasing the overall vehicle mass by 165 kg).
3. A battery pack that is five times the size of the pack in Scenario 1 (increasing the overall vehicle mass by 668 kg).

The first scenario goes back to a pack weight of 168 kg from the initial calculations. This allows for a battery with around half the capacity of the current Formula E pack, Pilling notes. Not surprisingly, this doesn't get far.

"That really is a very small battery for a vehicle of this performance, and it doesn't even get us to the ▶

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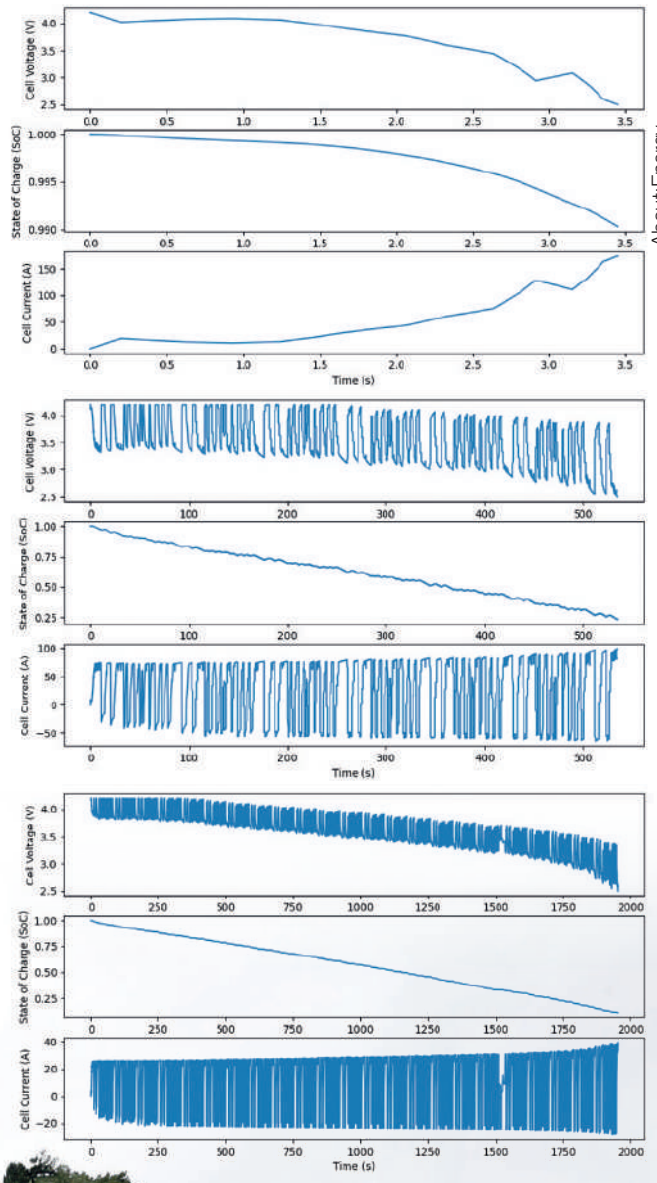
first corner," he explains. "We are limited on both power and energy, but again, it's worth pointing out that it's the energy density that's the real problem. The battery is not too far from delivering enough power but, even if it could, it would only have enough energy for about 4.9 laps."

Essentially, this just confirms what the earlier hand calculations had suggested. So, what happens if we double the size of the battery to a cell mass of 200 kg and an overall pack mass of 333 kg? This again is based around the Molicell P50B. With 235 cells in series and 12 cells in parallel, it gives a maximum pack voltage of 987V, which is within the existing limit for the MGU-K.

A 165 kg weight increase would be a significant penalty on a car that already weighs around 900 kg (including fuel and driver) but perhaps not prohibitive if other areas of the package were opened up for development.

"This is much closer to the current Formula E pack and we now have enough power to meet the power demands. We're usefully closer on energy, but still a long way off. In this scenario, the car would cover around 6.4 laps," comments Pilling.

Of course, it's easy to forget that Formula 1 hasn't always completed a full race ▶



RIGHT These graphs show the output of simulations based on battery packs maintaining the current F1 car weight (above) doubling the size (middle) and increasing the size by a factor of five (below)

BELOW Formula E lap times at Monaco are 20 seconds off Formula 1 pace, even with the front powertrains activated during qualifying

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distance on a single tank of fuel either. Refuelling has been used for long periods during the sport's history – most recently from 1994 to 2009, when it wasn't unknown for drivers to stop and take on fuel three or four times during the course of a race.

"Once we know how many laps the car can do, we can start to think about what might be realistic in terms of pit stops to swap the battery pack or indeed the whole car [like Formula E did in its first generation]," O'Regan points out. "Battery swaps with existing technology aren't generally that quick. We've not yet reached the point where they can be done in 30 seconds. But if you look at the innovation that's gone into tyre changes in F1, we believe the same focus applied to battery swaps could get them down to the sort of times that we see in a conventional pit stop."

There are other factors to consider here. For all its tactical intrigue, Formula 1 saw less on-track overtaking during the refuelling years, according to statistics from the F1 Overtaking Database. There's also a question mark over the message it would send out about electric vehicle range, after a decade and a half with no refuelling stops. Nonetheless, it's an interesting point to consider, particularly as many people's concerns about electric vehicles on the road actually stem from recharging options rather than battery range as such.

Heavy metal

Moving onto the third scenario, the elephant in the room (or rather sat on the track) is, of course, the weight. These simulations all assume that the power output remains unchanged, so even before we consider the impact that adding two thirds of a tonne would have in the corners, it's clear that this heavyweight car would be significantly slower in a straight line.

In this scenario, the battery pack expands to 235 cells in series and 30 cells in parallel. The total mass for the battery pack alone is now greater than a current Formula 1 car (minus fuel) at 833 kg. That's not quite as ridiculous as it might sound – the battery pack in the high performance Lucid Air road car is thought to be around the same mass – but it would certainly be a very different spectacle to existing F1.

Even this giant battery only holds around a quarter of the required energy capacity for a full race distance. In theory, the car could now cover 23 laps out of 70, with the same 40 per cent regen, which

About:Energy

RIGHT Kieran O'Regan (left) and Gavin White (right) - the two founders of About:Energy

LEFT The About:Energy team at their new battery testing facility in Southwark, London

BELOW Could the Monaco Grand Prix play host to a field of fully electric Formula 1 cars one day?

makes it roughly a three-stop race.

"We've kept the power output the same throughout the simulations, but this heavier pack could now handle a higher power output," notes Pilling. "On the other hand, increasing the power output would use more energy and require more pit stops, so it's a difficult compromise."

In each case, the simulation was run at an individual cell level. The cell power output is found by dividing the pack power by the number of cells in series, multiplied by the number of cells in parallel. Some significant assumptions have to be made to equate this to the pack-level performance, but that doesn't mean it's any less conclusive, Pilling points out.

"We're making a big assumption here by saying that every cell sees the same power and loses charge at the same rate," he says. "We're assuming they're all at the same temperature and the same state of charge. Clearly, it wouldn't be like that in reality – especially in Formula 1, where you'd expect to have very high power and very high cooling rates, so you're likely to see a considerable thermal gradient across the pack. If you were looking to optimise a design, you'd need to take all those things into account, but at the level of detail we're going into here, it isn't going to change the outcome."

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About:Energy

> *"There's no way lithium-ion technology can compete with the energy density of F1 fuel"*

Powerhouse

The bottom line remains that battery electric technology is still a long way off the energy density required for a Formula 1-style event. As we said at the start, that much perhaps won't come as a surprise, but this study also highlights the strengths of electric technology.

"What electric powertrains can do very well – even with current battery technology – is power output and regen capability. And that's exactly what F1 is tapping into with the 2026 regulations," says Pilling. "We've still got 70 kg of energy-dense fuel in 2026, but the power is now split roughly 50:50 between the combustion engine and the hybrid system. I think that's an important point to make – a 50:50 power split doesn't mean a 50:50 energy split, and instead it's playing to the strengths of both sides of the powertrain."

Even with more exotic cell chemistries in the future, it's likely that this will remain the case, O'Regan explains.

"It is difficult for conventional cylindrical cells to exceed energy of 350 Wh/kg," he says. "Some pouch cells are approaching 500 Wh/kg in commercial development, but they generally lack the power capability needed for motorsport applications. Solid-state and other next-generation chemistries could eventually surpass that 500 Wh/kg threshold, but those technologies are not expected to be ready before 2030. Until then, we're unlikely to see batteries that close the gap with liquid fuels in terms of energy density and power output."

None of this impacts the benefits of using power-dense cells in a hybrid setup, he points out. Unlike the combustion engine, there is no set homologation period for ERS batteries, although there are strict regulations around the weight, power and energy storage capacity, which might deter teams from carrying out additional work on proven battery hardware. However, Pilling believes that the strategic value of being able to monitor and control very precisely could be huge.

"Once the new regulations take effect next year, the battery pack will become a far more significant factor in race strategy. I expect a lot of teams will increasingly carry out very advanced battery pack simulations to get very accurate estimates for exactly how much energy they've got at different points across the race," he says. "That's where understanding your cell behaviour comes in. For this study, we ran three simulations over the course of a couple of minutes using battery cell models. If you go back 20 years, it would have taken many days of expensive physical testing to do the same thing."

So, while an all-electric format in Formula 1 seems unlikely – at least as long as combustion engines are a viable part of the solution – the importance of electrification seems set to grow. Certainly for 2026, the emphasis will shift further onto the electric side of the powertrain. RT

BELOW Green flag: Formula 1 is taking even greater strides than other series to ensure its 2026 fuel will be as sustainable as possible

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WITH GREAT POWER COMES GREAT RESPONSIBILITY

David Richardson of Coryton Advanced Fuels tells **Chris Pickering** exactly how Formula 1 is tackling its 2026 move to sustainable fuels

FORMULA 1 has always had its own particular way of doing things. So, if you're wondering why the series' forthcoming switch to sustainable fuels is headline news – a full four years after the World Rally Championship and others began their transition – read on.

The reality is that Formula 1's take on sustainable fuel is not the same as we have seen in other championships so far. It dives much deeper into the origins of the fuel to ensure that it's truly sustainable.

But surely that's the case with any '100 per cent sustainable' fuel? Well, yes and no.

It's not always possible to determine whether or not a particular molecule in a fuel was derived from a sustainable source. It's much the same as the electricity grid, where you can't claim ownership of an individual electron to guarantee that it comes from a wind turbine rather than a coal-fired power station. What matters is the overall percentage that comes from circular sources such as biofuel and e-fuel – where the carbon removed from the atmosphere during the fuel's production offsets some or all of the emissions released when it's burnt.

A large proportion of the feedstocks used in sustainable fuels for motorsport today rely on a system known as mass balancing. Essentially, this is a way of tracking the percentage of sustainable content that goes into a blend. For instance, if you were to add 10 litres of sustainable content to a fossil fuel blend, you could then declare the first 10 litres that you draw out of that mixture to be fully sustainable, even though it will most likely contain fuel from both sources.

This might sound like greenwashing, but it's actually a legitimate – and perhaps essential – tool for getting sustainable fuels into the mainstream. It's not practical to build a whole new oil refinery just to keep sustainable materials separate from their fossil-derived counterparts; it would be far more cost effective to mix everything and put it through one facility. In that scenario, mass balancing becomes the only way to track what percentage of the material going through the plant is sustainable.

This approach can be applied to any fuel component, but it's particularly useful for ingredients that are difficult or prohibitively expensive to produce from sustainable methods alone. As such, fuel manufacturers might use mass balancing to offset the carbon impact of certain additives, even if the majority of the fuel comes straight from sustainable sources.

> *"Formula 1 is diving much deeper into the origins of the fuel to ensure it's truly sustainable"*

Pure ambition

Mass balancing has allowed a number of major championships to transition to fully sustainable fuel blends quickly and relatively cheaply, but Formula 1 has set its sights on a more ambitious goal. The key ingredients of the fuel blends used from next year onwards will have to come from sustainable sources, without the use of mass balancing. Not only that, but they'll be subject to a rigorous auditing process to ensure that the overall environmental impact of the fuel is as low as possible.

"The Formula 1 technical team have made it very clear that they want to see the complete chain of custody for each ingredient in the fuel, going all the way back through to where it originated from. They want to make absolutely sure that there's no danger of any part of the fuel being misrepresented or misappropriated," explains David Richardson, business development officer at Coryton Advanced Fuels.

In a world still feeling the aftershocks of the Dieselgate scandal, any series championing green technology has to ensure that it can back up its claims – perhaps even more so when it's using low-carbon combustion engines rather than more overtly green options such as battery electric propulsion or hydrogen fuel cells.

From a technical perspective, this is a dilemma that all series face, but Richardson believes Formula 1 has had to approach it with an added degree of caution.

"Formula 1 is so popular, and it places so much emphasis on being at the forefront of technology, that it finds itself under the microscope more than any other series," he says. "They need to be able to demonstrate that they are doing things to the very highest standards. They can't ▶

afford to use components that might have negative connotations. And while mass balancing makes sense from an efficiency perspective, it can be hard to track the full chain of custody. It's also not an easy concept to explain to people – especially if you have fans or sponsors who might already be concerned about the image attached to the internal combustion engine."

There is a slight caveat here. The FIA states that all components in the 2026 Formula 1 fuels are required to be what it terms advanced sustainable (AS) chemicals (it eschews the '100 per cent sustainable' tag). These must be sustainably sourced and cannot be co-processed or co-mingled with non-AS components. However, some of the additives that are required for fuel stability, engine care and safety cannot yet be sourced sustainably, so up to 1 per cent of the fuel is allowed to come from non-AS components. This 1 per cent limit also allows for the presence of any legally required denaturants, as well as low-level contaminants or impurities. The bottom line, however, is that at least 99 per cent of the fuel must come from non-fossil sources, making this by far the most environmentally rigorous fuel specification in motorsport.

Audit process

Every single component in the 2026 Formula 1 fuels will be subject to an auditing process. The first set of criteria are that the feedstock (if it's bio-derived) must not compete with food production; aside from the 1 per cent allowance mentioned above, it must be shown to come from non-refined crude; the production process cannot be excessively energy intensive; and there must be a clear pathway to scale production up to commercial volumes (it cannot simply be produced in tiny ▶

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ABOVE Coryton Advanced Fuels is working in a consulting role with at least one Formula 1 fuel supplier

LEFT David Richardson, business development officer at Coryton Advanced Fuels

BELOW Key ingredients of the fuel blends used in F1 from 2026 will have to come from sustainable sources without the use of mass balancing

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Next, the component is assessed on the carbon intensity of sourcing and processing the feedstock, plus its infrastructure impacts. In total, the fuel blend must deliver a greenhouse gas saving of at least 65 per cent (or 70 per cent if the feedstocks are of a non-biological origin).

The regulations also define minimum and maximum figures for RON and MON, along with a set of distillation profiles. Plus, there's what's known as the 5/30 Rule, which states that at least 30 per cent of the hydrocarbon content of the fuel must be made of components present in less than 5 per cent concentration. This is designed to prevent exotic and potentially hazardous chemicals like toluene being used in high concentrations.

Crucially, as long as the fuel and its components meet these basic requirements, there are no real restrictions on what technologies can be used or how the GHG savings must be achieved. Notably, there is no rule on whether bio-based fuels or e-fuels must be used. This opens up some very interesting possibilities for the future, although it seems likely that all suppliers will have to go down the bio route for now.

"I think it's too early for e-fuels at the moment," comments Richardson. "We work with a lot of different technology companies and we're not aware of any of them producing any e-fuel that is viable for use in ongoing motorsport at the moment. There are some demonstration plants operational, but nothing that can provide the guaranteed continuity of supply that Formula 1 needs just yet."

ABOVE & BELOW
The switch to advanced sustainable fuels was the main attraction for new entrants like Audi (above). It also adds an extra technical variable as established giants like Ferrari (below) seek to repel the newcomers

The Porsche-backed HIF plant at Haru Oni in Chile is one example. Another is Aramco's NEOM pilot plant in Saudi Arabia, which is now said to be '80 per cent finished' and expected to be delivering fuel next year.

"There are companies out there actively involved in Formula 1 that I'm sure are looking to use their [e-fuel] products in the sport, but they will have to show that they can meet the requirements for carbon intensity and scalability before they can do that," summarises Richardson.

Coryton is working in a consulting role with at least one Formula 1 fuel supplier, but Richardson is remaining understandably tight-lipped about what chemistries are being used. He confirms that they are using biogenic feedstocks, with a multitude of options available for obtaining the carbon and hydrogen molecules that they need from those materials. ▶

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Future e-fuel

In many respects, e-fuels are the Holy Grail of sustainable combustion. Carbon capture raises the tantalising prospect that CO2 could literally be sucked from the atmosphere and turned into something useful. At the moment, though, it's just not quite there.

Here and now, most of Coryton's work with sustainable fuels focuses on biogenic sources, such as agricultural waste. The advantage of these feedstocks is that they already exist in reasonable volumes and monetising them for chemical processes generally has less environmental impact than leaving them to rot as waste. The downside is that the amount of waste produced by human activity and other sources that don't compete with food production is finite and unlikely to keep up with the demand for sustainable fuel production in the future.

"At the moment, bio technologies are a lot cheaper and a lot more scalable than e-fuels, but these things change," notes Richardson. "You have to bear in mind that setting up a [fossil fuel] refinery was not a cheap thing 150 years ago. Since then it has become very, very cheap because it's very efficient. Over time, we'd expect the same thing to happen again [with e-fuels]."

Even then, he says, it's unlikely that one energy carrier would come to dominate all applications: "Just as we have diesel for long haul applications and jet fuel for aviation, we will need to have a range of energy solutions in the future, which absolutely includes a place for battery electric powertrains and hydrogen as well."

> *"The bottom line is that at least 99 per cent of F1's fuel must come from non-fossil sources"*

The Fischer-Tropsch style processes used to create e-fuels generally lend themselves to diesel and jet chemistries, whereas further processing is required to create gasoline for light duty applications. This, Richardson believes, could sway the focus of e-fuel production towards heavy duty and aerospace applications, although those aren't the only factors.

"It can be difficult to certify an aviation fuel due to the constraints around safety. To do that, you need a stable and plentiful supply of ingredients. In theory, e-fuel could provide that. You could use CO2 from the air and hydrogen taken from desalinated seawater, both of which are effectively infinite in their supply."

Different chemistries

One of the key differences for Formula 1 fuel specialists working with sustainable chemistries is the range of ingredients that are available to them.

"With traditional fuels, you have literally hundreds of different molecules that you can choose from; the number of options is significantly reduced if you're only looking at those which can be sourced sustainably and which meet the other criteria in the Formula 1 rules," notes Richardson.

Formula 1 has long had one eye on sustainability in its fuels. Ironically, Richardson believes that the requirement to run an E10 ethanol blend, introduced in 2022, actually took the focus away from some of the more sophisticated sustainable technologies that ▶

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BELOW Coryton has long been providing sustainable fuel to global motorsport series such as the Dakar Rally

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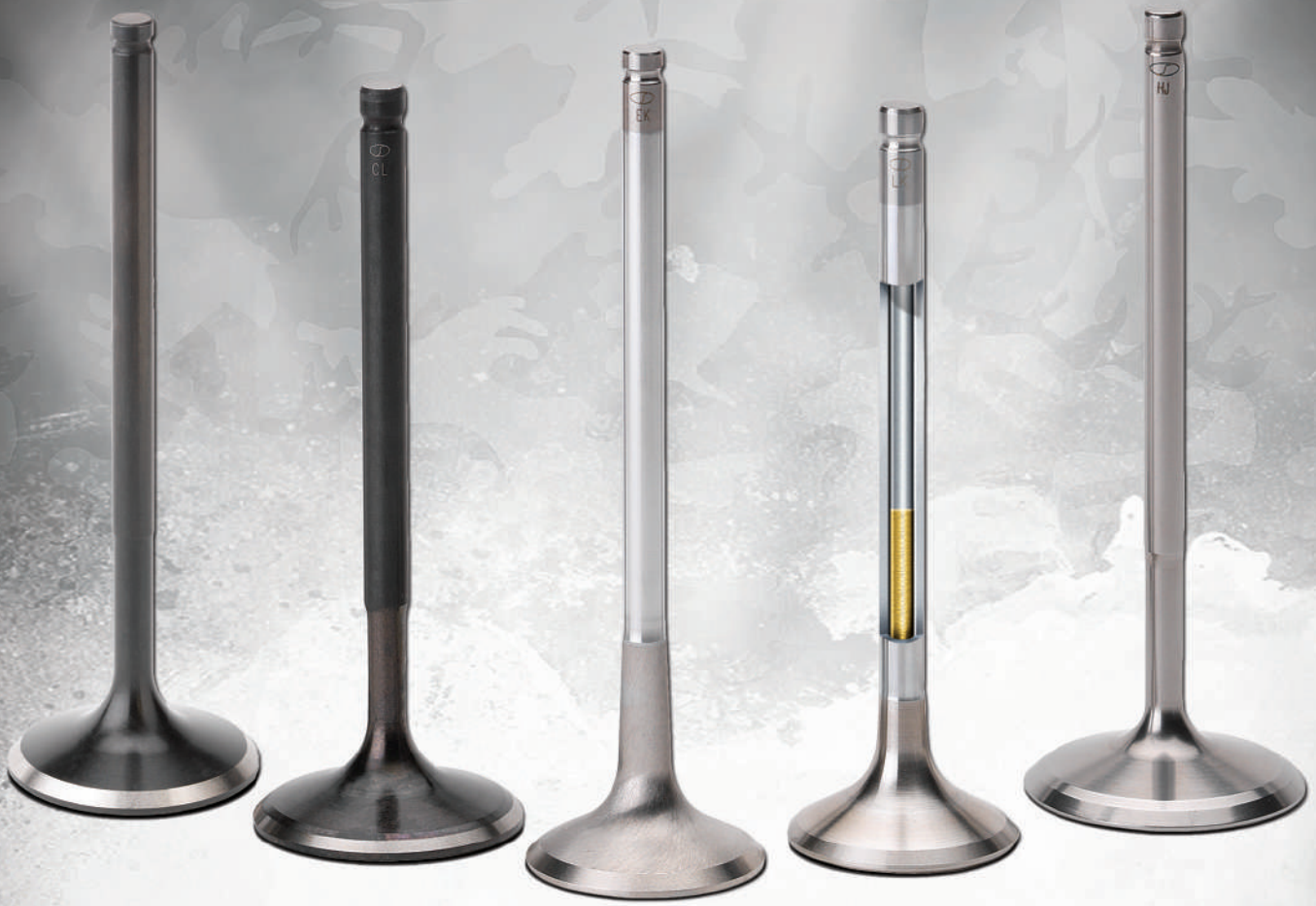

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had been in development in Formula 1 prior to that. Meanwhile, the desire to transition to sustainable fuels quickly, allied to their somewhat less onerous technical requirements, meant that series like the WRC could take what was essentially an off-the-shelf blend and adapt it to their requirements.

"The WRC doesn't have quite the same performance requirements to deal with, so for them it just needed to be acceptably close to what they'd used in the past," he says. "In Formula 1, each team has a unique set of engineering requirements, so they needed to wait until enough sustainable components were available for the fuel companies to tailor their blends to those specific requirements. This also means we've seen a return to more complex blends – so rather than having a fuel where perhaps 70 or 80 per cent is made from one molecule, we're seeing lots of different ingredients combined together in smaller concentrations."

While all Formula 1 engines will have to stick with the same basic template of a 1.6-litre turbocharged V6 next year, there will still be differences in the design philosophy, Richardson notes.

"The power unit developers will work hand in hand with the bigger oil companies to develop fuels based on their engine characteristics," he says. "That will point the fuel supplier towards a particular type of chemistry that's available within the sustainable market. You also have to remember that the engines do behave differently with different chassis. So the chassis engineers will always be working with the powertrain engineers and sometimes there's a bit of compromise required between them."

ABOVE Coryton supplies two '100% sustainable' fuel options – an E85 and a 95 RON E10 – to the UK's Formula Student competition

BELOW Every single component in the 2026 Formula 1 fuels will be subject to an auditing process

The next generation

While Formula 1 can rely on its budget and influence to operate at the cutting edge of sustainable fuels, the technology is beginning to trickle down to other areas of motorsport. Earlier in the summer, it was announced that Coryton would supply two '100% sustainable' fuel options – an E85 and a 95 RON E10 – to the UK's Formula Student competition.

For the cars on track, this equates to an impressive CO2 reduction of up to 85 per cent. But, as with Formula 1, the real impact comes with the message that it delivers.

"All the feedback we've had is that the transition to sustainable fuels in Formula Student has been very straightforward," comments Richardson. "For us, it's not just about spreading the word about sustainable fuels, but all the other technology that goes with that; the idea that there is a future in processing these chemicals in a sustainable way – not just for fuels, but for all the other applications like textiles and pharmaceuticals. It's a particularly relevant topic for motorsport as it crosses into the tyre industry and into composite manufacturing."

There's some evidence to suggest that engineering as a whole is being tarnished by the backlash against fossil fuels, he says: "When we first started talking to universities about this there was a view that they weren't getting the same flow of potential engineering students coming along because a lot of them just assumed everything was going to go electric. The idea that combustion technologies – and engineering in general – can be sustainable is really powerful. We've actually seen a rise in the number of internal combustion entries in Formula Student this year."

The fact that the internal combustion engine is staging a comeback among the next generation of engineers speaks volumes. For less technical audiences, however, the nuances of sustainable fuels are harder to communicate. Quite understandably, Formula 1 wants to ensure that its position is as clear as possible.

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BALANCE OF POWER

In our latest extract from 'Power Unleashed: Trailblazers Who Energised Engines…' **Karl Ludvigsen** reveals how Porsche resolved its early Can-Am turbo problems with impressive results

NOT without confidence, Porsche shipped Team Penske one of its latest turbocharged 4.5-litre engines at the end of January 1972 for installation in their test car. It was an awesome presence, said Woody Woodard: 'I was stunned by the monster size and complexity of the flat twelve-cylinder with twin turbochargers. It looked like it would be more suited for an aeroplane racer than a race car.'

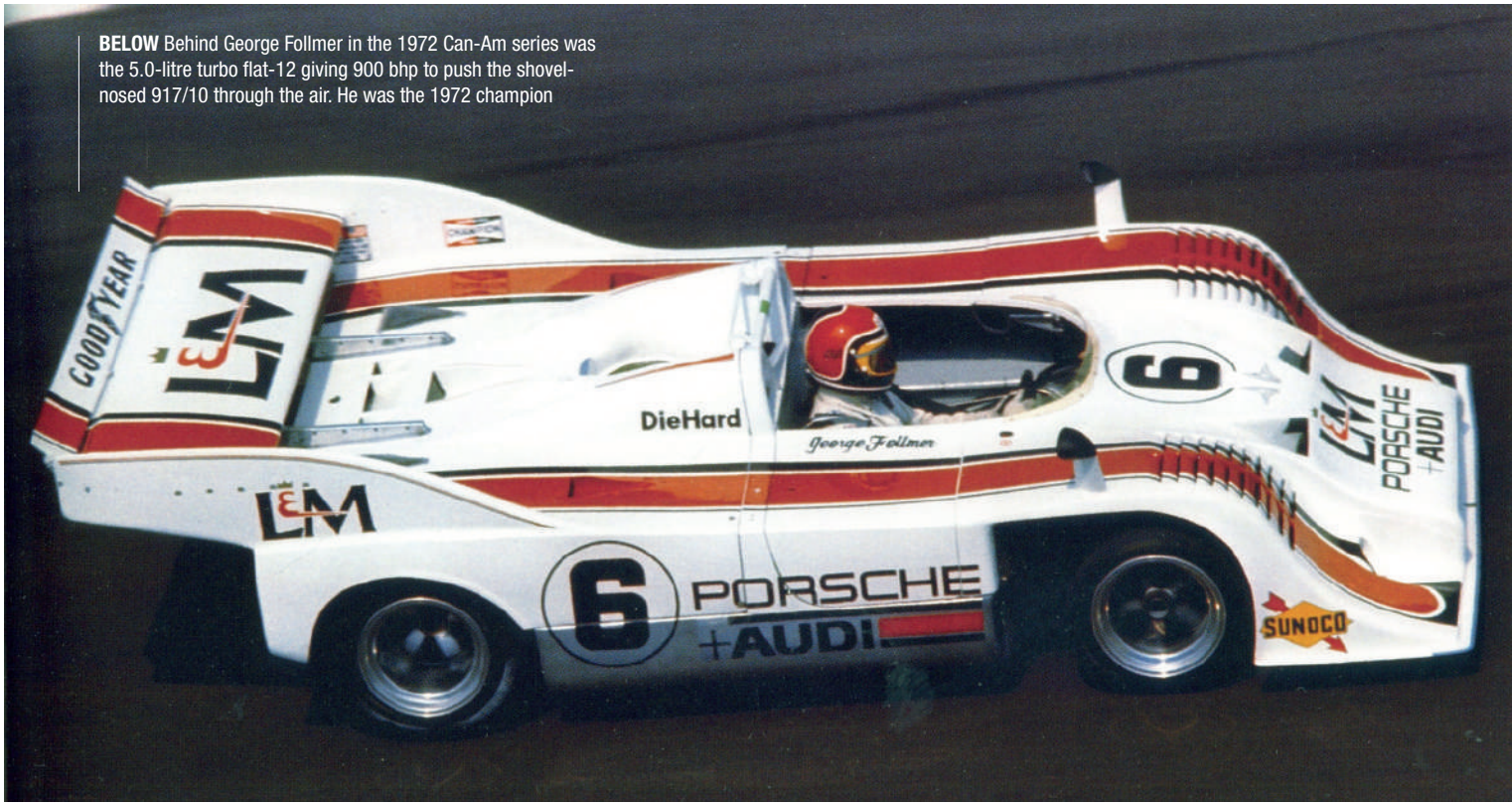
By the time they tested at Road Atlanta it was the last week of February and it was cold. They had to tow the car to get the engine started and then, wrote Donohue, 'we damn near couldn't keep it running. I tried to drive it a few laps and discovered that the throttle worked like an ignition switch—it was either wide-open power or off. It wouldn't run at any part-throttle condition.' 'The boost was very sudden,' Helmut Flegl confirmed. 'Coming out of a turn, if Mark stepped on the throttle too early he'd lose the car. Starting was very problematic—sometimes we had to tow the damn thing for 40 yards!'

Only by taking terrible risks on a lap that he could not duplicate was Donohue able to lap as fast as he had a month and a half earlier with the unsupercharged engine. Finally a turbocharger impeller failed and its pieces went into the cylinders, wrecking the engine. 'Mark wanted to know how turbocharging could work on the Offenhauser but not on the 917,' recalled a frustrated Flegl. 'How could we control the boost?' Their co-operation faced its first major challenge.

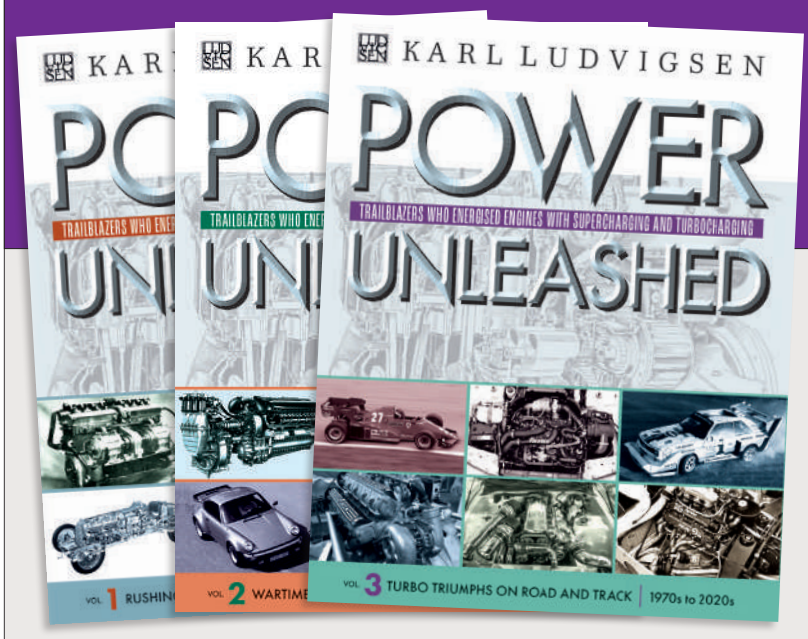
Another engine was shipped over, together with Flegl and Schäffer, in time for the car's first showing to press and sponsors at Road Atlanta on 20 March. It had what Donohue called a $3,000 paint job and it looked magnificent. But the engine, though improved, started and ran little better than it had in February.

Donohue and Flegl agreed that the driver should come to Germany for further tests at Weissach, which he did starting on 9 April 1972. On the less demanding circuit there Willi Kauhsen had lapped at 49.1 seconds with the turbocharged 917/10. Yet Donohue, struggling with its balky response, could do no better than 49.7. To Porsche it seemed that the driver had to try harder to adapt to the engine, while to Donohue and to Penske, who watched some of the tests, it seemed that the engine should be improved.

In April the fuel-injection system was



BELOW Behind George Follmer in the 1972 Can-Am series was the 5.0-litre turbo flat-12 giving 900 bhp to push the shovel-nosed 917/10 through the air. He was the 1972 champion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POWER UNLEASHED: Trailblazers who energised engines with supercharging and turbocharging

Written by **Karl Ludvigsen**.
Published by Evro Publishing.
Price: £395. ISBN: 9781910505373

In a three-volume work of astonishing depth and detail, complete with reader-friendly technical descriptions and magnificent illustrations, Karl Ludvigsen introduces the fascinating individuals who bet their businesses on boosting

completely recalibrated from scratch. 'On a naturally aspirated engine,' explained Helmut Flegl, 'fuel feed is determined by throttle position and engine rpm, but turbocharging adds a third element which we realised we weren't taking into account. I had to force the engine guys to run the dyno to show fuel input right through the rev range, not just above 5,000 rpm. From these readings we shaped a cam to control fuel admission according to boost level.'

The engine's fuel requirements were determined in both its blown and unblown modes of operation through its full speed range. Based on these findings Bosch supplied a new space cam that supplied the calculated fuel dosages. Making use of the pump's fitting that normally sensed atmospheric pressure, its control mechanism was made responsive to boost pressure as well as to engine speed and throttle position.

'This was the breakthrough we'd been looking for,' said Flegl. With this, he and his colleagues the Porsche crewmen felt, they surely had something that would satisfy the demanding American, the man they called 'a real driver-engineer.' They put the pump on an engine, the engine in the car and went back to the track.

After some initial adjustments, Donohue said, 'Suddenly it was right! It started, idled, accelerated and had immense torque over a wide throttle range! Almost immediately I was down to 48.9 seconds. I came in and said, "I am quite happy with this fuel pump." They were elated.' 'It was only six weeks before Mosport,' Flegl recalled, 'the 1972 season opener. Mark leaped on the telex to tell Penske.'

'They were so pleased they never let go of that pump,' Donohue recalled, 'which became known as the "happy pump". They kept it at Bosch and it was used for the calibration of all other fuel-injection systems we used. Whenever there was a problem they would always go back to the "happy pump".'

Now some of the improvements that Valentin Schäffer made to get faster boost response began to bear fruit. He installed a butterfly valve that opened to the atmosphere between each log manifold and the delivery pipe that brought compressed air from its turbocharger. This valve was connected to the throttle linkage in such a way that it opened fully just when the throttles closed.

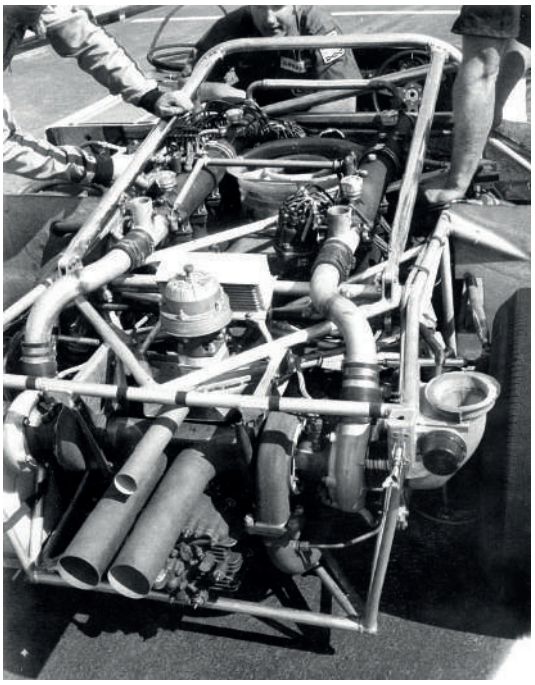
This system—mentioned earlier as being absent in the Indianapolis engines—vented pressure in the manifolds so the turbo impellers would find it easier to keep spinning because they wouldn't be pumping against a dead end. In this manner turbocharger speed was kept higher through a turn and readier to rev up when the throttles were reopened. Each delivery pipe was fitted with a small pressure-relief valve to vent any excess boost.

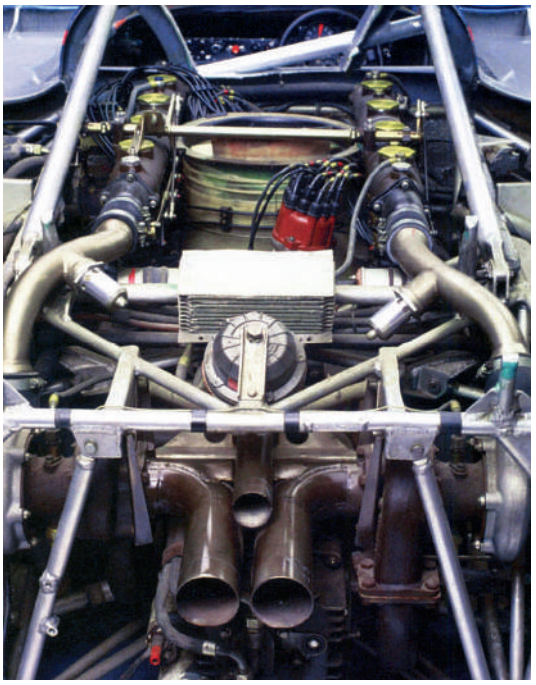
Before the first Can-Am race another novel device was fitted at the suggestion of Mark Donohue. Four suction-operated air valves, looking like tiny top hats, were fitted to the top of each log manifold. Because the throttles were quite a long way from the blower air inlets, Mark was concerned that the engine's low-speed response might be hampered by a lack of atmospherically inducted air. These valves admitted extra air for that purpose. When the boost pressure rose, the eight valves automatically snapped shut.

Supercharging pressures went higher during development. Normal boost was stepped up to between 1.2 and 1.4 bar. At that level the 4.5-litre engines used in the Interserie in 1972 produced 840 to 850 horsepower. The lack of mechanical troubles with this engine encouraged the engineers to try the turbo-blowers on the 5.0-litre version. This worked sensationally well. Test-cell visitors in May saw such an engine taken momentarily to a reading of more than 1,000 bhp.

Durability testing reassured Porsche that the 5.0-litre was sound enough to be relied on in the Can-Am series. Three of the engines used in the Penske cars in 1972 registered peak outputs between 894 and 918 bhp at 8,000 rpm. One curve published by Porsche showed 910 bhp at 7,800 rpm on a boost of 1.3 bar and a peak torque of 707 lb-ft at 6,400 rpm. Such an engine weighed 617 pounds.

The 5.0-litre's performance in the car was ▶





LEFT For 1973 the heavily revised 917/30 flat-12 looked little changed but its 5.4 litres could deliver 1,560 bhp on 2.2 bar boost on the dynamometer – too much for use in racing

BELOW Mark Donohue, who curated every inch of its 1973 Can-Am-sweeping machinery, thought the 917/30 the best racing car ever. The flat-12's turbocharging did the job

even better than its sensational specifications because the larger displacement further reduced the turbocharger response time. Said Ernst Fuhrmann, 'With a lot of detail work we have been able to reduce the delay to a few tenths of a second, but it is not yet quite so precise as an unsupercharged engine. That means that the driver must still take into account a small delay.' In its 5.0-litre size the base engine also had more thrust to offer at part throttle when the boost level was low.

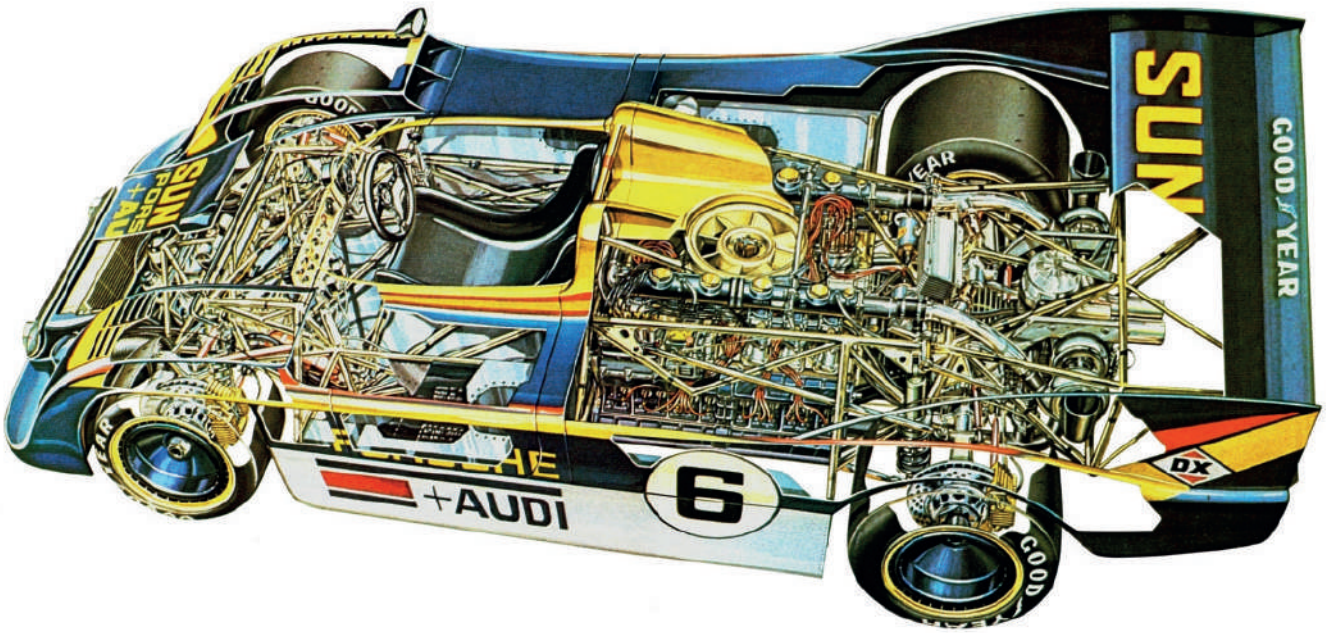
One of the revised turbomotors was airlifted to Philadelphia for installation in the Penske test car at the team's base on Newtown Square. The 917/10 then went to Riverside for evaluation. 'It was an unbelievable transformation,' said Woody Woodard. 'The car was a rocket right out of the box so we were feeling very good.'

Also feeling good were the Porsche designers and developers, who moved during 1972 to new quarters at Weissach. Although farther from the production lines where their creations were made, they were now nearer the test tracks where their brainstorms met their nemesis—or went on to glory.

In this case glory was the result. Equipped with a more rugged transaxle that had four forward speeds and no reverse, the turbocharged Porsche 917s went on to overpower the opposition in both 1972 and in 1973, Porsche's final year in the Can-Am series.

After Donohue was benched by a crash in the first season George Follmer became champion, while Mark recovered to win that honour in 1973 with a new Porsche 917/30 that Woody Woodard said 'had 1,550 horsepower on tap if we wanted it. However in the race we'd dial it to 1,100 horsepower and leave it there or maybe dial it down some more.' That got the job done.

In 1975 one last challenge beckoned to the 917/30 and Mark Donohue. In 1974 A.J. Foyt had set a world closed-course speed record of 217.854 mph with his Indy Coyote on the 2.66-mile banked track at Talladega, Alabama. Considering this, Donohue ▶



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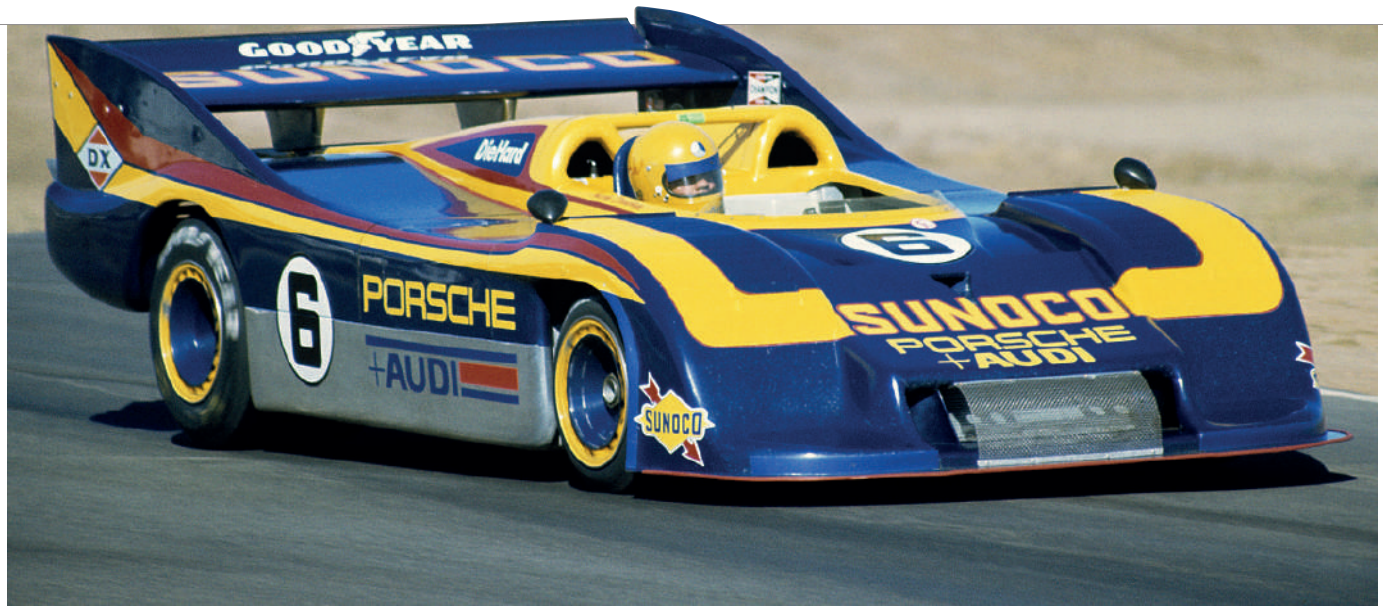


realised that at last he had a chance to take advantage of the high speed that he and Porsche had engineered into the shape of the 917/30. He decided that all he had to do was take the Penske car to a high-banked track and put his foot in it.

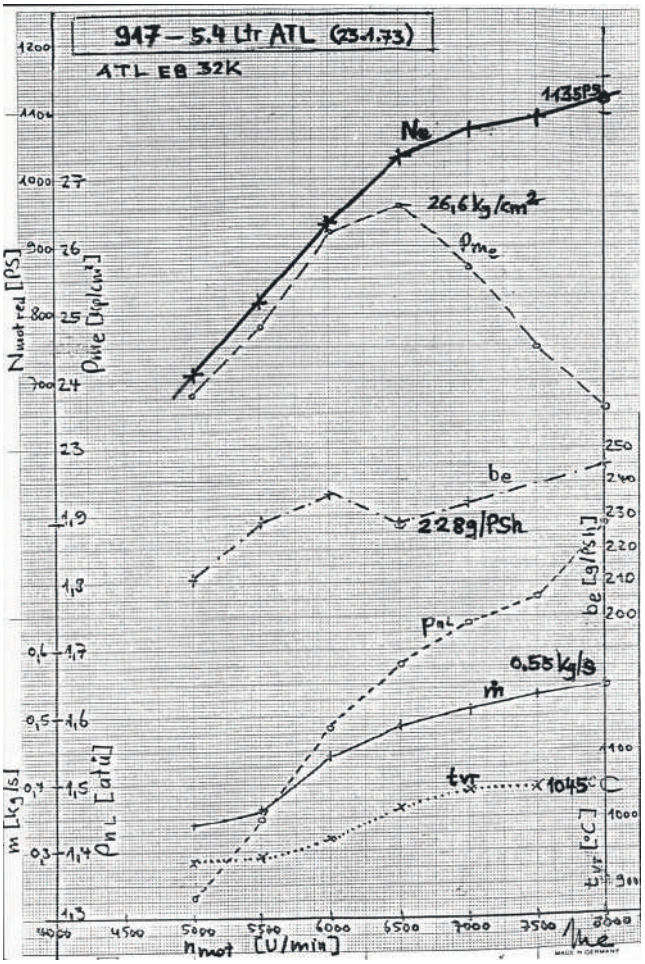
The talented driver-engineer took this on as a personal project through his own Racemark Company, headquartered in Hallandale, Florida. Obtaining sponsorship from the makers of CAM 2 motor oil, he commissioned Porsche on 28 April 1975 to rebuild two 5.4-litre engines with intercoolers. Although intercoolers had not been used in the 917/30 during the 1973 season, the two units had been designed, built and supplied by Porsche in case they were needed.

Mark air-freighted his engines to Weissach and asked that they be overhauled, tested and rebuilt afterwards, one as a 5.4-litre and the other as a 5.0-litre, with large turbochargers. Having reached agreement that the total cost would not exceed $22,000, he sent a Racemark down-payment check for $15,000 from Monaco on 10 May.

With its charge cooled by the big air/air intercoolers mounted in the car's extreme tail, the flat-12 could hold its maximum 1,500 horsepower for short periods. 'Testing that engine was a big worry,' Hans Mezger related. 'Our chief Dr. Fuhrmann said it had to run on the dyno for three minutes at full power to show it was reliable enough to do the job. That was a really difficult test. I don't really know if they ran it on the dyno for the full three minutes because everybody who was there became very anxious. The whole engine was running very hot.'

Completed in June, the rebuilt engines arrived at the Philadelphia airport on 3 July. In the meantime, Donohue had arranged to run the Porsche at the same fast Talladega track where Foyt had set his record. He and his crew trimmed the big car to the lowest drag consistent with stability. In tests on 23 July he turned a warm-up lap of the Alabama oval at 218.6 mph before being timed at 220.645 mph. The record was well within sight.

On 9 August, in the midst of a NASCAR racing event and using their timing facilities, Mark was given the track. He put his foot down for the record laps. On his second lap he saw a few raindrops in the Alabama sky. Should he continue? Mark asked himself, answering at the same time with a pedal-to-the-metal effort. He set a new official record



ABOVE Much was learned about aerodynamics in the change from 1972 to 1973 to the benefit of the Can-Am 917/30 Porsche, with which Mark Donohue won six of the eight races

ABOVE RIGHT Former Porsche engineer Ernst Fuhrmann was in charge of the company from 1972. He pushed his engineers hard to put their racing turbochargers in Porsche's road cars

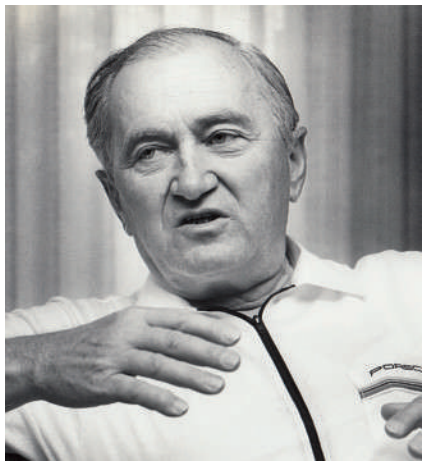
LEFT Hans Mezger's record of a test run of the blown 5.4-litre flat-12 on 23 January 1973 showed 700 bhp at 7,000 rpm, rising to 1,030 bhp at 6,500 and 1,135 bhp at 8,000

RIGHT Porsche built intercoolers for its 917/30 but they were not used until Donohue tackled the closed-course speed record. On 9 August 1975 he set a new record at 221.120 mph

for the world's fastest closed-course lap at 221.120 mph. 'When he came back in,' said a member of the team, 'the whole back of the car was literally on fire. They put it out quickly so there was very little damage.'

This was the last racing achievement of the 917/30 and, tragically, of Mark Donohue. Ten days later he was dead. He succumbed two days after he crashed his Formula One Penske on the Österreichring, the same track on which the Porsche 917 had won its first victory and, thanks to a Can-Am version, had achieved the design breakthrough that allowed it to dominate the endurance races of 1970 and '71. Much of the credit for the 917's similar domination of the Can-Am series in 1972 and '73 was owed to Donohue.

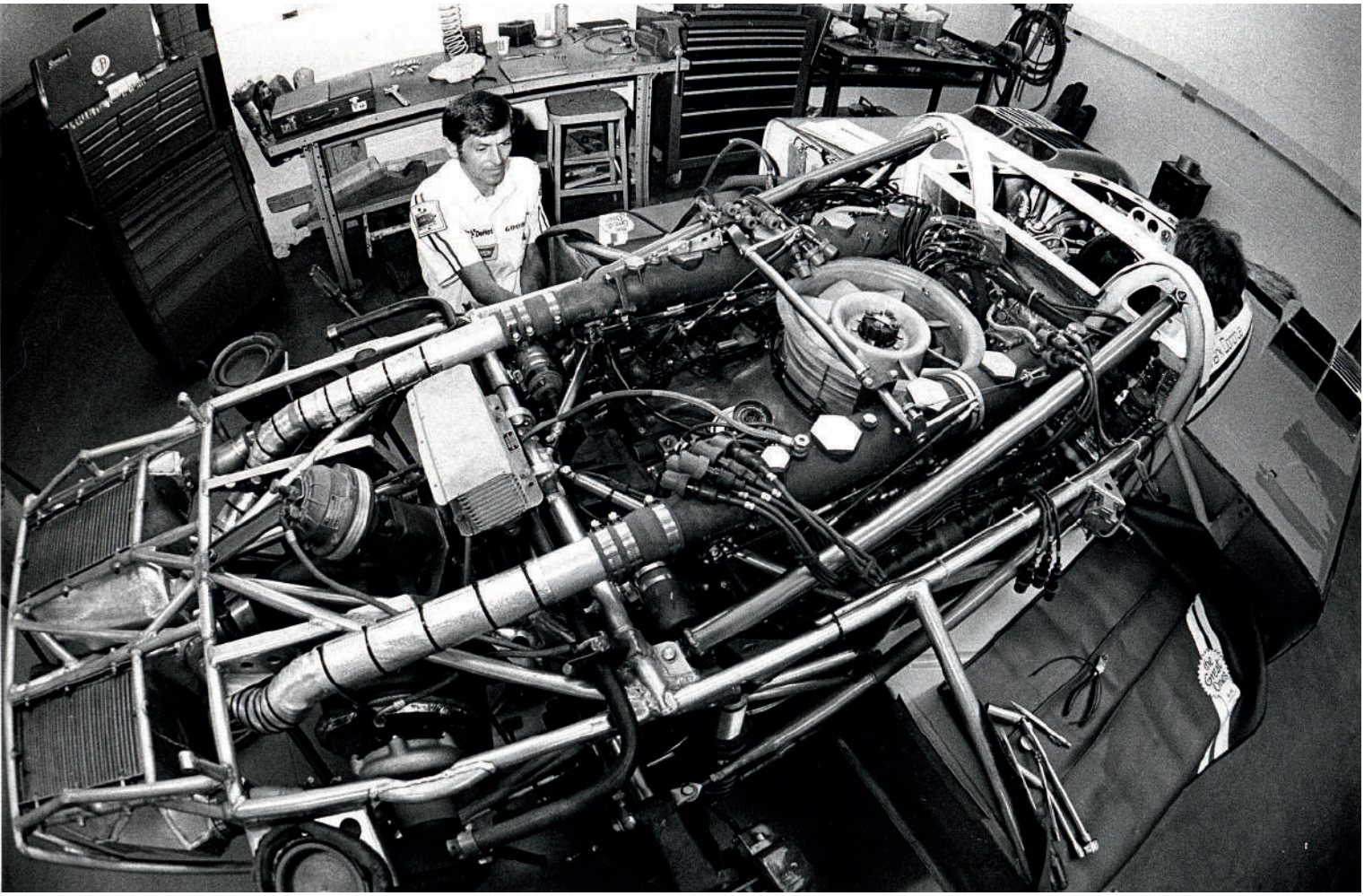
As the man in charge of Porsche since early 1972, Ernst Fuhrmann became an oft-quoted public figure. This was a sharp contrast to his earlier role as a back-room boy in the Porsche design office. Even in that environment his flair and ambition asserted themselves. The 'Fuhrmann cam' for the engine of the Type 356 first brought



him public recognition. He gained more when he was revealed as the designer of the Type 547 that became famous as the 550 and Carrera engine. Fuhrmann created and promoted that four-cam engine precisely because he wanted to rise above the ruck of his fellow engineers. He wanted to prove what he could do.

Short in stature, high-voiced, unprepossessing in appearance, Fuhrmann compensated with his ability. It carried him to the top of his profession. He could be dryly practical. He flabbergasted the meticulous Penske team when he saw their beautiful McLarens at Indy in 1972. 'Why do you polish those cars?' he asked. 'Polishing doesn't make them go any faster.' But when his own cars were on the track Fuhrmann was a superstitious romantic. At the time a race was starting he would light a candle at his home. He would keep it burning throughout the event. If the candle flickered out, it happened from time to time that the Porsche did too.

'It belongs to us,' Fuhrmann explained, 'this racing business. We are often asked why we spend so much on it. From advertising, or motivation, or engineering know-how, there is no single aspect that accounts for it.' Like his customers Fuhrmann enjoyed fast cars. He was fascinated by the performance the turbochargers unlocked from the engine of the Can-Am 917. Surprisingly little change in the twelve's basic structure had been needed to cope with a sensational increase in power. RT



IS THE FUTURE OF MOTORSPORT SUSTAINABLE?

Mark Skewis introduces the nominations for this year's RACE TECH technical awards, the winners of which will be revealed at the World Motorsport Symposium

THERE are moments in motorsport, as in the wider world, when the task ahead can feel overwhelming. When the leader of the free world dismisses global warming as the "greatest con job ever perpetrated in the world," the idea of racing sustainably, while also providing the technological know-how to tackle the climate crisis, can seem like an impossible undertaking.

But motorsport has always thrived when facing seemingly impossible odds. It is also worth remembering that sustainability is not only about decarbonisation. The collapse of the FIA World Rallycross Championship this year after its headlong rush into electrification remains a cautionary tale. Likewise, the retreat of both the BTCC and the World Rally Championship from their much-trumpeted hybrid projects underlines a key truth: motorsport must first be financially sustainable if it is also to be environmentally sustainable. No technology, however promising, can flourish if the business model beneath it fails.

Even Formula 1, like the world beyond it, has appeared to waver at times. The suggestion that the sport might retreat into the nostalgia of V10s rather than commit to its next-generation hybrid engines was widely read as a crisis of confidence. Yet the championship is pressing ahead with its planned 2026 switch to Advanced Sustainable Fuel – a step that has the potential not only to shift public perception, but to demonstrate that racing can pioneer solutions with genuine relevance to the road car industry.

And while the outside world may at times be rowing back on its green pledges and chanting "drill, baby, drill", motorsport in 2025 has continued to move forward with remarkable momentum. Last month's inaugural Extreme H World Cup was another landmark moment – the sport's first ever hydrogen-powered championship under FIA regulation. Crucially, the fuel cell stacks provided by Symbio for this new series are not racing curiosities but technology with direct application to commercial transport and other sectors in the wider economy.

> *"Motorsport must first be financially sustainable if it is also to be environmentally sustainable"*

Toyota, like Extreme H, leads the hydrogen pioneers, straddling the line between fuel cells and hydrogen combustion. It has stepped up its long-running partnership with MissionH24, while also developing hydrogen combustion-powered concepts for the World Endurance Championship and rallying.

This isn't just about concepts or future promises either. Increasingly, practical solutions are making an impact at the sharp end. Formula 1's European season now operates with Aggreko's low-carbon power management solutions, delivering significant reductions in event-related emissions. Such developments show that motorsport isn't merely *talking* about sustainability – it is embedding it into the day-to-day reality of running the sport.

Which is why, as we gather for this year's Race Tech World Motorsport Symposium, it feels timely to ask: Is the future of motorsport sustainable? The answers will come not only in bold concepts, but in the ways the sport continues to balance innovation with commercial reality, ensuring its place at the forefront of technology and society alike.

Before that, though, we celebrate some of the pioneers already leading the way, with the nominations for this year's Race Tech Technical Awards.

DINO TOSO RACECAR AERODYNAMICIST OF THE YEAR

McLAREN

Nominated for its MCL39 F1 car

McLAREN's aerodynamics department delivered a masterclass in technical execution and bravery with the MCL39 – a car that has redefined the standards of efficiency and integration under the current ground-effect regulations. In what was expected to be the closest season yet, McLaren's aero team not only defended its constructors' title but pulled clear of a field that had spent two years converging.

Much of the MCL39's advantage lay in its devastating cornering performance, particularly through medium-speed turns, and its unrivalled tyre usage. Despite not excelling under heavy braking or over

ABOVE The MCL39 romped to the Constructors' title with six races remaining

bumps, the car's aerodynamic platform is so stable and efficient that it remains, on average, the most effective across all circuits.

Team principal Andrea Stella credits "innovation" as the cornerstone. He suggests that the team's bold approach to its 2025 car, when the temptation for many would have been to stay in the comfort zone with a concept that was already a title winner, has often been overlooked.

"There was loads of innovation applied to what was last year's car," he said, "and this required quite a bit of bravery to commit to the amount of changes we made for the MCL39. Our engineering understanding and execution were challenged to the leading edge of our knowledge."

From the front suspension layout – with its decoupled lower wishbone and carefully managed brake airflow – to extreme levels of anti-dive and anti-lift ensuring a consistent aero platform, every element demonstrates integrated thinking between mechanical and aerodynamic design.

McLaren's aero team has achieved what many thought impossible in a regulation cycle nearing its end: they have innovated beyond convergence.

NASCAR
Nominated for its A-post flaps

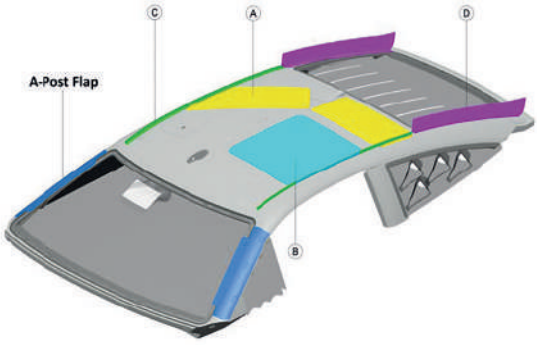
NASCAR's introduction of new A-post flaps on its Cup Series race cars marks a major advance in aerodynamic safety engineering. Implemented from Daytona in August, the system is designed to reduce the risk of cars going airborne during high-speed drafting – a persistent danger at superspeedways such as Daytona and Talladega.

The flaps, which self-deploy during sudden yaw or lift, are expected to increase the likelihood of a car staying on the ground in a 90-degree spin by 40–50%. This breakthrough follows several dramatic flips in recent seasons, including Ford driver Ryan Preece's spectacular airborne crashes at Daytona. By adding these new devices, NASCAR aims to reduce lift early in a spin – keeping tyres in contact with the track surface for longer and allowing the car to decelerate more safely.

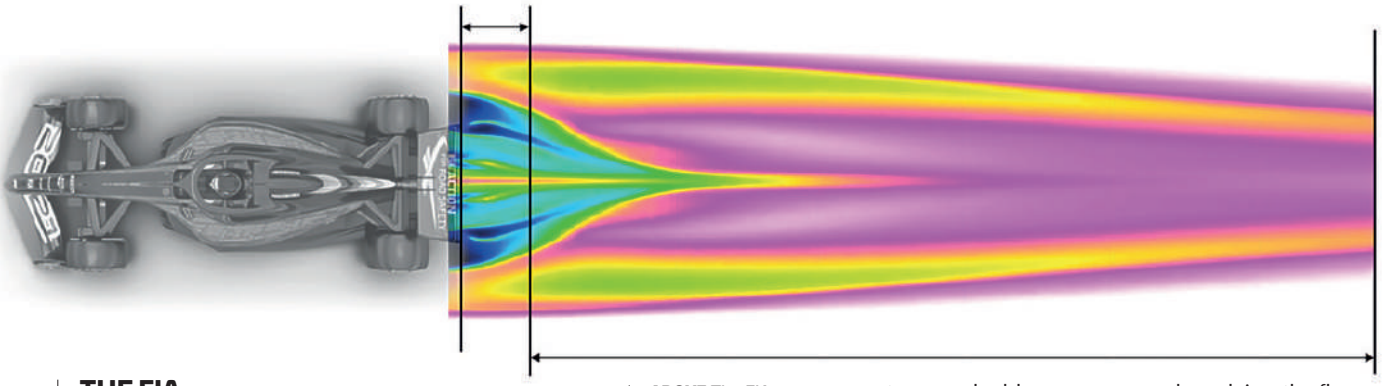
Developed under the leadership of Dr Eric Jacuzzi, NASCAR's vice-president of vehicle performance innovation (aero), the flaps evolved from an unviable concept into a proven solution after extensive simulation, wind-tunnel testing at GM's facility, and real-world trials with Cup teams during Goodyear's Michigan tyre test. "It started out as a concept that wasn't really viable," said Jacuzzi. "Then we had a couple of brainstorms and came up with this idea – it proved to be very, very effective."

The A-post flaps are held shut by magnets and mechanically linked to the existing roof flaps. When a roof flap deploys, a cable opens the corresponding A-pillar flap, disrupting airflow and cutting lift. They will not impact speed or drafting ability during normal racing.

By addressing one of stock-car racing's most dangerous aerodynamic phenomena, NASCAR's A-post flap innovation sets a new benchmark in safety-driven design – keeping the racing spectacular, but the cars firmly on the ground. ▶



ABOVE & RIGHT Ryan Preece's flip at Daytona earlier in the season (right) was one of the catalysts for the new flaps (above)



THE FIA

Nominated for its use of AI with legacy wake data

THERE is a fascinating new take on the age-old poacher versus gamekeeper theme going on in Formula 1 at the moment. Just as every team is exploring how to use the might of Artificial Intelligence to make their cars go faster, so the governing body is keen to harness the same technology to improve both the racing spectacle and safety.

An unprecedented amount of simulation was used to determine the last ruleset, introduced for 2022, to improve the racing by reducing the cars' turbulent wake. But this good work was quickly undermined once the teams developed their cars.

During its CFD studies, the FIA had split the cross-section of the wake into four regions and monitored the total energy loss in each one, extending for a distance of 40 metres behind the car. Looking ahead, it wondered whether this technique could offer a way of quantifying the impact that each proposed set of regulations would have on the wake generation.

The snag was that reliable data for a selection of real-world cars would be required to establish these baselines. The FIA did have access to data of the flow directly behind the cars, which wouldn't compromise the teams' IP. However, the teams themselves don't waste any valuable aero resource by solving the flow 40 metres behind the car, because it would have no performance benefit to them.

ABOVE The FIA successfully established that legacy CFD wake data could be leveraged to train a generative model able to accurately predict a full downstream wake domain from a limited input

The clever solution that the FIA aerodynamicists hit upon was to use AI to predict the full downstream wake based on this limited portion available to them. Using the layered Convolutional Neural Networks AI approach – a type of deep learning algorithm that's commonly used for computer vision and speech recognition tasks – the team achieved its mission with a startling degree of accuracy. The same technique was then double-checked on its own data from Formula 2 cars – again with remarkable accuracy.

AI will change our world. That is a given. Could its influence be a positive in F1? The FIA's groundbreaking work offers encouraging signs.

BELOW The satellite Ferrari works squad won an eventful race

FERRARI

Nominated for its Le Mans-winning 499P

YOU wait 58 years for an outright victory in the Le Mans 24 Hours, then three come along in succession!

Ferrari's third straight win in the endurance classic owed less to a faultless race and more to the relentless efficiency of the 499P's aerodynamics. The AF Corse-run #83 entry of Robert Kubica, Yifei Ye and Phil Hanson endured penalties, a gearbox glitch, and even a spin. Yet even with all three Ferraris encountering setbacks, the Prancing Horse still had the pace to secure the win against Porsche's best effort.

The margin of victory might have been smaller than in each of the previous two races, but ironically Ferrari's dominance was more complete. Porsche was unable to match its pace, despite having played an evo joker on its aerodynamics. Notwithstanding that, Ferrari's aero efficiency was apparent in every condition.

"There were two kinds of car at Le Mans in 2025 – those that were quick in the straight line and those that weren't," said Toyota's technical director David Floury. Ferrari was firmly in the former camp. The 499P maintained balance across full and low fuel, hot and cool track conditions, and on old as well as new tyres – areas where rivals faded. That consistency, rooted in aero efficiency, allowed Ferrari to win Le Mans even when the race itself was far from perfect. ▶

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RACE POWERTRAIN OF THE YEAR

EXTREME H

Nominated for its hydrogen fuel cell-powered Pioneer 25

THE launch of Extreme H in Saudi Arabia this October marked a historic milestone: the world's first FIA-approved hydrogen racing competition.

The journey has been tricky at times – "The 'H' stands for Hydrogen, but also Houdini: we don't know how we pulled this off!" confessed the category's founder, Alejandro Agag, in the wake of the ground-breaking FIA Extreme H World Cup in Qiddiya City.

Building on Extreme E's progression from using hydrogen fuel cells for car charging in Season 1, to powering 80% of its entire event operations with hydrogen by the final event of Season 4, Extreme H showcased what could be achieved at even greater scale.

The Pioneer 25, Extreme H's spec chassis, is built around a hybridised hydrogen-battery powertrain. Various configurations were tested during development, but the finished design uses a single Symbio StackPack 75 module – a 75-kW unit comprising 400 individual cells – that acts as a generator rather than a prime mover. Fuel cells work by feeding hydrogen and oxygen into a catalyst, which triggers an electrochemical reaction that produces electricity. In this case, the electricity is directed into a Fortescue Zero 36 kWh battery pack mounted low in the chassis. That battery then supplies a pair of Helix motors with up to 400 kW of peak output – more than five times the nominal rating of the fuel cell.

The fuel cell was sized for steady-state generation, while the battery handles the peaks, delivering instant torque for acceleration and recovering energy under braking. The design reflects heavy-duty transport practice: by keeping the stack in its optimal efficiency window, durability is improved and the same logic can be applied to hydrogen-powered buses and trucks.

ABOVE Symbio's 'StackPack75' hydrogen fuel cell system performed well in the desert on Extreme H's debut

PORSCHE

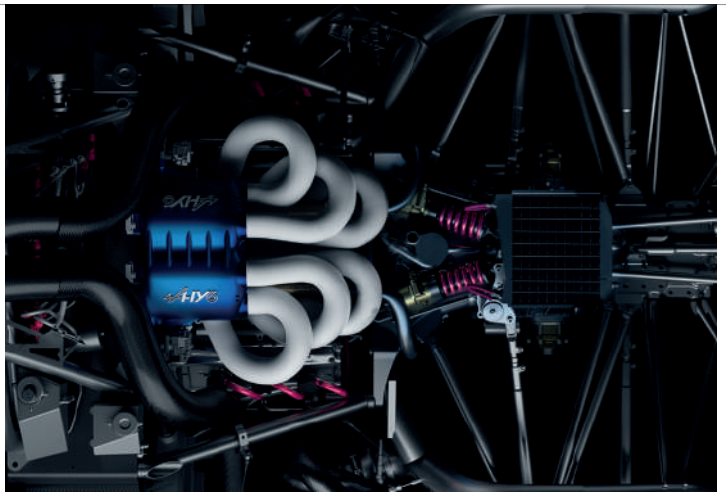
Nominated for its Formula E powertrain

FORMULA E's racecars have become faster and more aggressive with each passing season, but this year one constant remained: Porsche has become the benchmark for electric racing.

A first for Formula E, this year's GEN3 Evo car used both front and rear powertrains, giving it all-wheel drive (AWD) – and increasing energy regeneration to 600 kW – when enabled during qualifying, race starts, and in ATTACK MODE.

Pit Boost, which harnessed Fortescue Zero's fast charging expertise, added a further strategic

BELOW Porsche became the FIA's first official Formula E Manufacturers' World Champion



RIGHT The Alpenglow HY6 ran at Spa and Le Mans

BELOW Honda aced the introduction of IndyCar's supercapacitor-based hybrid system

element to the racing.

But over multiple seasons and circuits now, Porsche's 99X Electric has proven both durable and consistent, operating effectively across demanding thermal and energy-limited conditions.

Factory support from Porsche proved decisive throughout the season, with customer team Andretti claiming multiple podiums and Cupra Kiro contributing valuable midfield points in key rounds. The combined effort overcame a spirited challenge from Jaguar and Nissan to clinch both the Teams' and Manufacturers' titles. Added to the previous year's Drivers' crown, the Weissach squad is now the first to have scooped all of electric racing's honours.

More than a race winner, the 99X Electric serves as a cornerstone of Porsche's future EV strategy. The lessons learned in high-efficiency power conversion, regenerative braking and software-controlled torque management feed directly into its next generation of road-going electric sports cars. That was a fact underlined by its recent decision to focus on Formula E, while withdrawing from the World Endurance Championship.

ALPINE

Nominated for its Alpenglow HY6

ALPINE has developed the first high-performance engine designed entirely around the specifics of hydrogen combustion – not adapted from a gasoline base, but created from a clean sheet to explore the future of zero-carbon motorsport. Drawing directly on the simulation methodologies and combustion expertise honed in Formula 1, the Viry-Châtillon engineering team has achieved over 820 hp and 800 Nm from a 3.5-litre twin-turbo V6, with peak efficiency surpassing 41% at full load.

The Alpenglow HY6 prototype, publicly demonstrated at the 2025 6 Hours of Spa and at Le Mans – where it registered a top speed of 302 km/h – serves as a live development platform for this hydrogen direct-injection engine. Its stable high-load combustion, controlled knock characteristics and exceptional responsiveness mark a breakthrough in hydrogen engine design. Detailed CFD analysis guided the injector and chamber geometry to manage supersonic hydrogen flow and achieve precise air-fuel mixing, while advanced turbocharging strategies balance lean-burn efficiency with transient performance.

The result is a power unit that retains the emotional character of internal combustion – revving to 9,000 rpm and delivering a full sensory experience – while eliminating CO_2 emissions and minimising NOx through careful mixture and temperature control.

Alpine views hydrogen combustion as a complementary technology to fuel cells and e-fuels, combining visceral performance with near-zero emissions. Its work on liquid hydrogen storage, direct injection and thermal management positions the HY6 as a critical step toward hydrogen-powered endurance racing and a potential blueprint for sustainable high-performance propulsion across motorsport, trucking and even aerospace applications.

HONDA RACING CORPORATION USA

Nominated for its hybrid IndyCar powertrain

HONDA Racing Corporation USA delivered a landmark season in IndyCar during 2025, proving that its hybrid powerplant integration is not just reliable – but race-winning across every discipline.

While Honda's combustion engine had long been proven, 2025 was the first full season in which the new hybrid unit was mandatory. Honda's engineers managed challenges in packaging, reliability, energy storage, deployment strategy, and thermal management, executing sophisticated calibration across superspeedways, short ovals, street courses, and road circuits.

The reward for that labour was a dominant season where the manufacturer's teams and drivers won 12 of the first 15 races, setting a new record for Honda in the current era. It swept the Drivers', Manufacturers', and Rookie of the Year crowns, also winning the coveted Indianapolis 500.

"The more you understand, the luckier you get," suggests David Salters, president of Honda Racing Corporation USA, and the company's simulation prowess was arguably the bedrock of this success. ▶

WILLIAM KIMBERLEY GREEN TECH AWARD

GOODYEAR

Nominated for its 55% sustainable truck racing tyres

TYRES, brakes and materials remain an awkward area for motorsport's push towards a sustainable future but Goodyear's new tyres for the European Truck Racing Championship demonstrated that significant progress is being made.

The new racing tyres are composed of 55% sustainable materials, achieved through innovations such as silica derived from waste rice husk ash and carbon black produced from alternative feedstocks.

That change is not just symbolic: durability improvements mean that each team can complete a season using significantly fewer tyres.

A circular approach underpins the project. Used racing tyre casings are retreaded and repurposed for on-road haulage, extending their life well beyond the track. Tyres that once ended their service life in competition now gain a productive second life in freight transport.

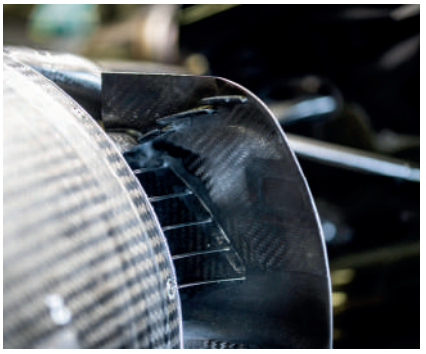
Transparency was a priority throughout. Each tyre carries ISCC PLUS certification, enabling the tracking of sustainable raw materials across the supply chain and ensuring that claims are independently verified.

Crucially, these gains have not come at the cost of performance. The new compound has delivered improved grip, particularly in wet conditions, while maintaining the stability and consistency demanded by 5-tonne racing trucks across a wide variety of circuits.

ABOVE Goodyear's development for the ETRC could have a positive impact on the wider haulage sector

SYENSQO

Nominated for the bio-resin used on the Mercedes W16 F1 car



CARBON fibre has long been central to Formula 1 performance, but its petroleum-based origins present a challenge as the sport pursues ambitious sustainability targets. Progress toward renewable alternatives has been gradual, yet this season Mercedes-AMG PETRONAS F1 Team took a significant step by debuting a bio-based composite during the Azerbaijan Grand Prix.

The W16 ran with new rear brake duct wheel shields manufactured using a resin system that replaces 30% of its traditional petroleum-derived content with renewable feedstocks. Developed in collaboration with composites supplier Syensqo, the material marks the team's first use of a sustainable carbon fibre composite on a performance-critical race component.

Brake duct shields are a particularly demanding application given their complex aerodynamic design, exposure to high thermal loads and vulnerability to debris. Demonstrating that the new resin can withstand race conditions provides important validation for the technology's potential within motorsport and beyond.

A new wave of responsible manufacturing in high-performance sport is a great news angle. But it will remain a fairy tale unless the performance of the more sustainably made components equals or surpasses that of traditional carbon fibre. Mercedes' use of bio-based composite in race conditions highlights the growing momentum in this area and the increasing belief that sound practice can replace sound bites.

FORMULA 1

Nominated for its low-carbon energy generation system

FORMULA 1 took a major step towards achieving its challenging sustainability goals this season – without even touching its racecars.

It is not the elite athletes who cause the problems at major sporting events – even if they are travelling at 200 mph – but instead the infrastructure around the occasion.

This season Formula 1 has cut 90% of event-energy emissions at European Grands Prix. Working with Aggreko, that staggering reduction has been achieved through the development of a new, centralized, low-carbon energy generation system that uses renewable sources such as hydrotreated vegetable oil (HVO) biofuel, solar panels, and battery power.

The programme was successfully trialled at the 2023 Austrian Grand Prix, where it reduced the need for at least 30+ additional generators from other suppliers and slashed associated carbon emissions. It was expanded to three races in 2024 before its full rollout this season at all European GPs in key areas such as the Paddock, Pit Lane, and Event Technical Centre.

F1 is famed for its technical innovation, something it now demonstrates in its paddock as well as on the racetrack. It is a shining example of how large event operators can accelerate change by learning from this progressive approach in reducing emissions. ▶

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DON BURGOON MOST INNOVATIVE NEW MOTORSPORT PRODUCT OF THE YEAR

INFRARED KINETICS

Nominated for its vehicle tracking system

INFRARED Kinetics (IRK) has developed a breakthrough vehicle tracking system that directly addresses one of motorsport's most high-profile and persistent problems: track limits enforcement and real-time race control.

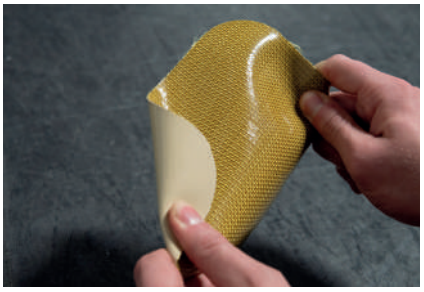
The 2023 Austrian Grand Prix, with more than 1,200 potential track limits infringements and hours of post-race steward reviews, highlighted how current GPS-based solutions are no longer fit for purpose. Motorsport demands instant, accurate, and reliable data, and IRK is confident it can deliver exactly that.

Its infrared-based platform provides sub-5cm accuracy at 100Hz refresh rates with near-zero latency, working flawlessly in fog, glare, rain, or night conditions. Unlike satellite-based systems, IRK builds a localised, high-fidelity environment that guarantees reliability under race conditions.

At Mallory Park, IRK successfully completed a live proof of concept, tracking multiple race cars in real time with total precision. The system instantly identified off-track moments, proving its ability to deliver immediate, indisputable evidence for stewards, teams, and broadcasters. This level of accuracy not only ensures fairer, safer racing but also reduces the burden on officials and eliminates delays in final classifications. Beyond governance, IRK's technology opens up new possibilities for driver coaching, immersive broadcasting, and fan engagement – linking real-world racing to virtual environments and creating entirely new ways to experience and watch motorsport. The Holy Grail for gamers?

AERO TEC LABORATORIES

Nominated for its EXO-based 922-C fuel bladder material



IT'S easy to forget just how deadly motor racing once was. But Romain Grosjean's crash at Bahrain in 2020 was a grisly flashback to the days when Formula 1 drivers took their lives in their hands. The crash not only demonstrated how far motorsport safety had come, but it proved the catalyst for a remarkable new breakthrough.

A detailed investigation of the incident by fuel cell provider ATL ultimately led to the development of an innovative new fuel tank technology, in collaboration with chemical giant DuPont.

ATL became aware of a new aramid fibre material that DuPont was developing primarily for body armour. Known as Kevlar EXO, it's been described as the biggest leap forward in ballistic materials since Kevlar was developed in the 1960s.

Among the new material's benefits are an improvement of around 30 per cent in the strength of its raw fibres. Combined with a special polymer developed in-house by ATL, this translates into material that's some 22 per cent lighter than the company's current FT5 benchmark. Crucially, it also performs flawlessly with today's latest sustainable fuels.

Every F1 team is now currently utilizing a safety fuel bladder constructed from ATL's 922-C with Kevlar EXO. This year the technology was also introduced to the World Rally Championship.

Behind the scenes, ATL and DuPont have worked tirelessly to overcome the challenges presented by the introduction of new sustainable fuels in the extreme conditions presented by the WRC. That work, integrating Kevlar EXO into reimagined fuel bladders, helped save the day when a new supply of sustainable fuel had to be hastily introduced to the WRC mid-season. It will pay further dividends when Formula 1 introduces its much-vaunted near-100 per cent sustainable fuel in 2026. Such a quantum leap might not have been possible without DuPont's new material and ATL's know-how and IP.

CALIRAD

Nominated for its AI Safety Camera

DEVELOPED in partnership with the FIA and the FIA Foundation, Calirad's AI Safety Camera (AISC) represents a breakthrough in rally spectator safety and event management. First deployed in the 2025 FIA European Rally Championship, this compact, autonomous system uses AI-driven image recognition to detect and report potential spectator hazards in real-time – bringing World Rally Championship-level oversight to regional and national events.

Housed in a self-contained 3 kg module, the AISC integrates three stereoscopic cameras, a GPU-enabled processing unit, GPS and 4G antennas, and an independent power supply. As the rally car travels each stage, the cameras continuously scan the roadside. Any anomaly – such as a person standing in a restricted zone – is automatically logged and transmitted to Rally Control as a geotagged image. There, FIA safety officers verify and act on alerts via a web-based dashboard, enabling immediate intervention by marshals.

The system's robust engineering allows reliable operation across extreme rally conditions, from the -20°C snows of Sweden to the +60°C cockpit heat of Mexico. To overcome patchy network coverage, each stage is supported by a Starlink terminal that synchronizes data as cars cross the finish line.

Calirad's design philosophy prioritises scalability and simplicity. The AISC requires no external infrastructure and minimal operator training, making it viable for events that lack WRC-level resources. Every incident is stored for post-event review, supporting iterative safety improvements within and

between rally legs.

By combining stereoscopic vision, edge computing and AI classification within a ruggedised, standalone package, Calirad has delivered a genuinely transformative tool for motorsport safety management – one that actively prevents accidents rather than simply analysing them after the fact.

ABOVE The compact Theta Seat Sport simulators offer a cost-effective way to bring additional drivers into the simulation environment

FORTESCUE ZERO

Nominated for its Pit Boost ultra-fast charging technology

A LONG wait to charge your electric car may soon be a thing of the past thanks to Pit Boost, the ultra-fast charging technology designed by Fortescue Zero.

Pit Boost, which was launched during this year's Formula E World Championship, is a 600-kW mobile power unit that can deliver 4 kWh of energy. Designed to meet Formula E's exacting criteria, Pit Boost has enabled pit stops to become a feature of the electric race series, with cars stopping to receive 10% of their race energy in just 30 seconds. Even more impressively, having charged one car, the unit has sufficient capacity to be able to charge the second car moments later.

The global nature of Formula E required Pit Boost not only to be ultra-powerful but also sufficiently mobile for the units to be transportable with Pit Boost featuring at races across four continents, including the iconic Monaco street circuit, Tokyo and the season finale in London. The 600 kW units weigh around 316 kg, making them incredibly power dense at 1,900W per kg. This is all packaged into a rectangular frame measuring 1,250 mm long and 450 mm wide and 885 mm tall and set on four suitcase-style wheels to ease manoeuvrability.

The power is delivered by a multiphase DCDC connection inside the unit, which was developed specifically for this project by Fortescue Zero, while a critical element of Pit Boost's ability to deliver such fast charges is the near-seamless "handshake" technology that the team have created. This means the energy is flowing into the car's battery almost as soon as Pit Boost is connected, a far cry from the experience of a customer charging their road car.

While performance is a critical part of motorsport, reliability is too and Pit Boost, in conjunction with Fortescue Zero's trackside team that are at every race and testing session, has stood up to the challenge. Over the course of Season 11, the various Pit Boost units, with each of the 11 teams having a unit as well as a back-up for the FIA, have delivered over 1.5 MWh of energy across 386 full power boosts with an almost 100% success rate.

The project has shown how far advanced ultra-fast charging now is. In just a few years from now, this cutting-edge technology will no doubt be adapted to be an everyday feature of charging electric vehicles, with cars being charged in a matter of minutes and that feat will owe much to the breakthroughs made by the Pit Boost team at Fortescue Zero.

ANSIBLE MOTION

Nominated for its Theta Seat Sport multi-sim platform

DESIGNED and built in Hethel, England, Ansible Motion's Driver-in-the-Loop (DIL) simulators have been at the forefront of global automotive and motorsport development for more than 15 years. Used by OEMs including Honda, Ford, GM and BMW, and teams from NASCAR to WRC, they enable engineers to accelerate innovation while reducing the need for carbon-intensive on-track testing.

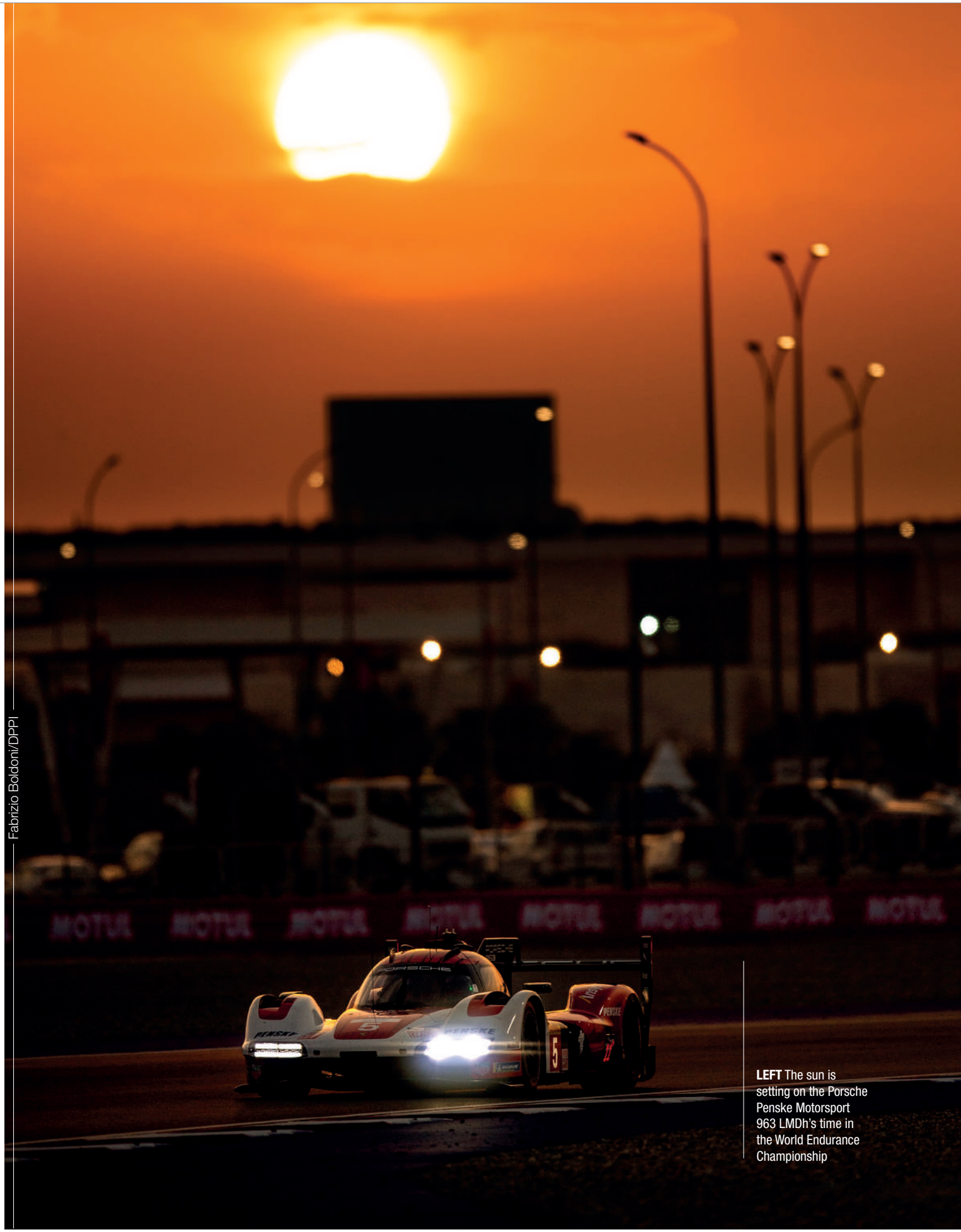
In 2025, Ansible Motion delivered its first multi-simulator platform to the DS Penske Formula E team – a world-first for professional motorsport. Four new Theta Seat Sport simulators were integrated with an existing Delta S3 DIL simulator to create a five-unit system. Multiple drivers and vehicles can now be modelled simultaneously, reproducing complex inter-car and inter-driver interactions that previously required transporting cars, equipment and staff across continents. The same development tasks can now be achieved entirely within a virtual, repeatable laboratory environment – dramatically reducing emissions, logistics costs and turnaround time.

The Theta Seat Sport offers a scalable, reconfigurable architecture adaptable to multiple race series, from affordable gaming-grade control setups to fully immersive configurations with active steering, pedal, harness and helmet-load systems.

Unlike heavy hexapod platforms, Ansible Motion's stratiform-based dynamic simulators impose minimal ground loading and can be installed on standard industrial floors – reducing facility preparation and deployment time. DS Penske's multi-sim system was operational within just three months of order.

"Having already experienced the capabilities of the Delta S3," said DS Penske team president Phil Charles, "we were keen to expand to multiple, simultaneous drivers to explore inter-vehicle and inter-driver situations."

"The benefit of using multiple simulators is that you can understand how multiple drivers impact a scenario," commented Mark Thommyppillai, simulator group manager at Ansible Motion. "That's particularly relevant in Formula E, where you don't tend to have the run-off area and the space between the cars that you have in, say, Formula 1. The drivers are much more influenced by what's around them – including the other cars." RT



Fabrizio Boldoni/DPPI

LEFT The sun is setting on the Porsche Penske Motorsport 963 LMDh's time in the World Endurance Championship

HYPER TENSION

Gary Watkins brings us the inside story of Porsche's imminent withdrawal from the World Endurance Championship – and what it means for the future of sportscar racing

PORSCHE has axed its factory entries with Penske Racing in next year's World Endurance Championship. It's not the first withdrawal of a major manufacturer from the series in the Hypercar era; Lamborghini took that undistinguished honour. But it is the most significant. That means this has to be regarded as the first bump in the road since the start of the new golden era of sportscar racing in 2023 even as more manufacturers are gearing up to join the party.

The reasons are twofold. The first is that the withdrawal concerns two of the most distinguished names in worldwide motorsport. Porsche is arguably *the* sportscar manufacturer, a marque that has been ever present in long-distance racing for more than 70 years. It is also the most successful manufacturer in the history of the Le Mans 24 Hours with 19 victories. Penske, meanwhile, has won just about everything worth winning in motorsport including US open-wheelers, NASCAR and sportscar racing., not forgetting its lone F1 grand prix victory back in 1976. Unlike Lamborghini, Porsche is also a WEC frontrunner: it won the 2024 drivers' title and it had an outside chance of retaining its crown heading into the 2025 season finale in Bahrain on November 8.

The second reason the decision not to race on with the Porsche Penske Motorsport 963 LMDhs in 2026 can be described as a 'bump' is – at least partly – the rationale behind it. Porsche Motorsport had to make savings, or at least to be seen to be making savings, at a time when the marque is in trouble. Road car sales are down and back in the summer its CEO Oliver Blume announced a plan to reduce the workforce by 10% before 2029 as he outlined a future in which Porsche sales peak at 250,000 a year rather than the 300,000-plus of 2024.

As engrained in Porsche's psyche as motorsport is, it still has to be regarded as something of a frivolity when rank and file members of the workforce are facing redundancy. Porsche had to lose one of its three factory programmes, and it was WEC that got the chop. This choice has to be a worry for the WEC and its organiser, the FIA and the Automobile Club de l'Ouest.

Porsche's participation in the FIA Formula E World Championship dating back to the 2019/2020 season was safe from the get-go. The German manufacturer has made much of its three-pronged approach to motorsport that takes its lead from its road car range: it involves full electric vehicles, hybrids and pure combustion cars. There isn't anywhere else for it to race a full-electric car save for Formula E which, pertinently, is heading into a new era with the introduction of the Gen4 car for the Season 13 campaign starting at the end of 2026.

That made it a straight choice between the WEC Hypercar and IMSA SportsCar Championship GTP class assaults with the 963 LMDh developed out of the Multimatic Motorsports chassis spine. Thomas Laudenbach, vice-president of Porsche Motorsport, has refused to go into the intricacies of the decision-making process, but he has conceded there were both sporting and marketing considerations.

"Motorsport belongs to the company and motorsport has to give a contribution: the financial aspect is there and also the sporting aspect," says Laudenbach. The financial aspect refers to the fact that Porsche sells more cars in North America than anywhere else.

It is also where it has enjoyed the most success with the 963 since the car came on stream as one of the first wave of LMDhs in 2023. It won the drivers', manufacturers' and teams' crowns in year two and retained them at this year's Petit Le Mans IMSA finale at Road Atlanta in October, also claiming a clean sweep of the IMSA Michelin Endurance Cup silverware. Back-to-back victories at the Daytona 24 Hours and the Sebring 12 Hours at the start of the campaign helped push it to those titles.

Asked if the successes in North America and the fact that there appears to be a more level playing field in IMSA than in WEC was a factor, Laudenbach suggests that this author had "answered your own question". He added: "The original idea was you can build one car, you can race in both championships and we can control costs to a feasible budget, and race, of course, on a level playing field. It didn't work out everywhere the same. This, of course, had an influence on our decision."

There is one key difference between the IMSA and WEC campaigns: PPM has won Daytona twice with the 963, this year and last, meaning that Porsche's tally in the US enduro has now surpassed the 19 Le Mans wins. The circumstances of its second-place finish at the WEC blue riband this year appear to grate.

> *"Porsche has been ever present in long-distance racing for more than 70 years"*

Laudenbach doesn't mention the Balance of Performance when talking about Le Mans for a simple reason: he's not allowed to under the WEC sporting ▶

Porsche/Juergen Tap

Javier Jimenez/DPPI

best result — and most competitive performance — on what can be presumed its final hurrah at Road Atlanta. A machine that was racing for the second time with a revised rear suspension design introduced at the previous IMEC round at Indianapolis finished fourth and it was right up there among the quickest cars over the final four hours of the race uninterrupted by yellow flags.

Lamborghini scaled back its LMDh programme in year two when it was forced to go it alone after the split with its original partners, Iron Lynx and its DC Racing Solutions parent company. In year one it entered one car in the full WEC and one in four of the five IMSA enduros, but new rules in the world championship forced Hypercar manufacturers to enter two cars from this year. Lamborghini blamed the new regulation for its decision in its statement announcing the WEC withdrawal.

That should be regarded as a simplification of the situation. It would be better described as the start of the breakdown of the relationship with Iron Lynx. As rumours of the Lambo pull-out were gathering, the Italian team was saying it was ready to run two cars in 2025. What it wasn't ready to do, it seems, was pay for them.

Iron Lynx, whose WEC set-up incorporated the Prema Racing single-seater team that came into the DC Solutions empire in September 2021,

regulations. But he is clearly saying that it didn't do its job.

"Second place is not bad if you look at the competition out there, but on the other side it did hurt because the #6 car was close to what I would call a perfect race," he says. "Frankly speaking the #6 should have won the race, full stop."

The #6 entry shared by Kevin Estre, Laurens Vanthoor and Matt Campbell was delayed only by a slow puncture early in the race, whereas the winning Ferrari 499P Le Mans Hypercar entry and the third-placed factory car from the Italian manufacturer suffered multiple hiccups. If you accept that the BoP is meant to level the playing field to such an extent that who wins and who doesn't should come down to driver performance, strategy and reliability then the BoP missed the mark at Le Mans. On the first and last of those criteria Porsche was definitely ahead of Ferrari over the course of the 24 Hours.

Ahead of the decision to leave the WEC as a factory Laudenbach suggested there were "things we can improve" in the WEC. "We are having a very good dialogue, but the only thing I would say at this stage is that for sure we need improvement," he said at the Austin round in September. He again made a veiled reference to the BoP when he added: "We have seen a lot of results that are questionable."

Is there a trend?

No is the definitive answer to that one: there is no link between the Porsche and Lamborghini decisions to quit WEC. A unique set of circumstances is always behind the decision when a manufacturer withdraws from any high-level series. The explanation of the Italian manufacturer's departure from WEC is quite different to Porsche's.

Lamborghini pulled out of the WEC ahead of the 2025 season, instead focusing on a one-car IMSA campaign in the five IMSA enduros. That programme, conducted under its own banner with Riley Motorsports as a service provider, was axed in the late summer. Officially the SC63 is on hold, but few expect to see the car race again. There's an irony to that given that it notched up its

Charly Lopez/DPPI

LEFT Porsche will continue in the IMSA SportsCar Championship, where it has enjoyed much success including two straight wins at the Daytona 24 Hours

LEFT Roger Penske was on hand in Bahrain to help celebrate Porsche's victory in the 2024 WEC drivers' championship

BELOW Porsche has pledged keep making its 963 LMDh available to privateers even once its factory assault ends at the end of 2025

> *"The Balance of Performance missed the mark at Le Mans"*

was key to getting the Lamborghini LMDh programme off the ground. Or rather the finance it brought to the programme was. But what it apparently wasn't prepared to do was step up its funding to run a car that was proving uncompetitive in both arenas. Lamborghini, part of the Volkswagen group but a relatively small company in contrast to many of its rivals in WEC and IMSA, didn't have the resources to fill the financial gap.

A year on, Lambo has probably raced for the last time with its LMDh because the marque has failed to find a partner to make the contribution it needs to continue in IMSA. The uncompetitiveness of the SC63 always made that unlikely. Its decision to pause the programme was made before the rear suspension upgrade under evo joker rules that have crossed over into LMDh from LMH.

There is nothing to suggest that Atlanta was anything but the final race for the SC63. It appears there are no plans to put the car back in the Windshear wind tunnel in North Carolina for the new round of homologation testing. All cars competing in IMSA and the WEC will now go into the tunnel, whereas previously only LMDhs – including the Alpine that only competes in WEC and the Aston Martin LMH – had gone to the States for this section of the homologation process. WEC-only LMH cars were put through their paces in the Sauber tunnel, which is now no longer available after Audi's takeover of the Swiss F1 team.

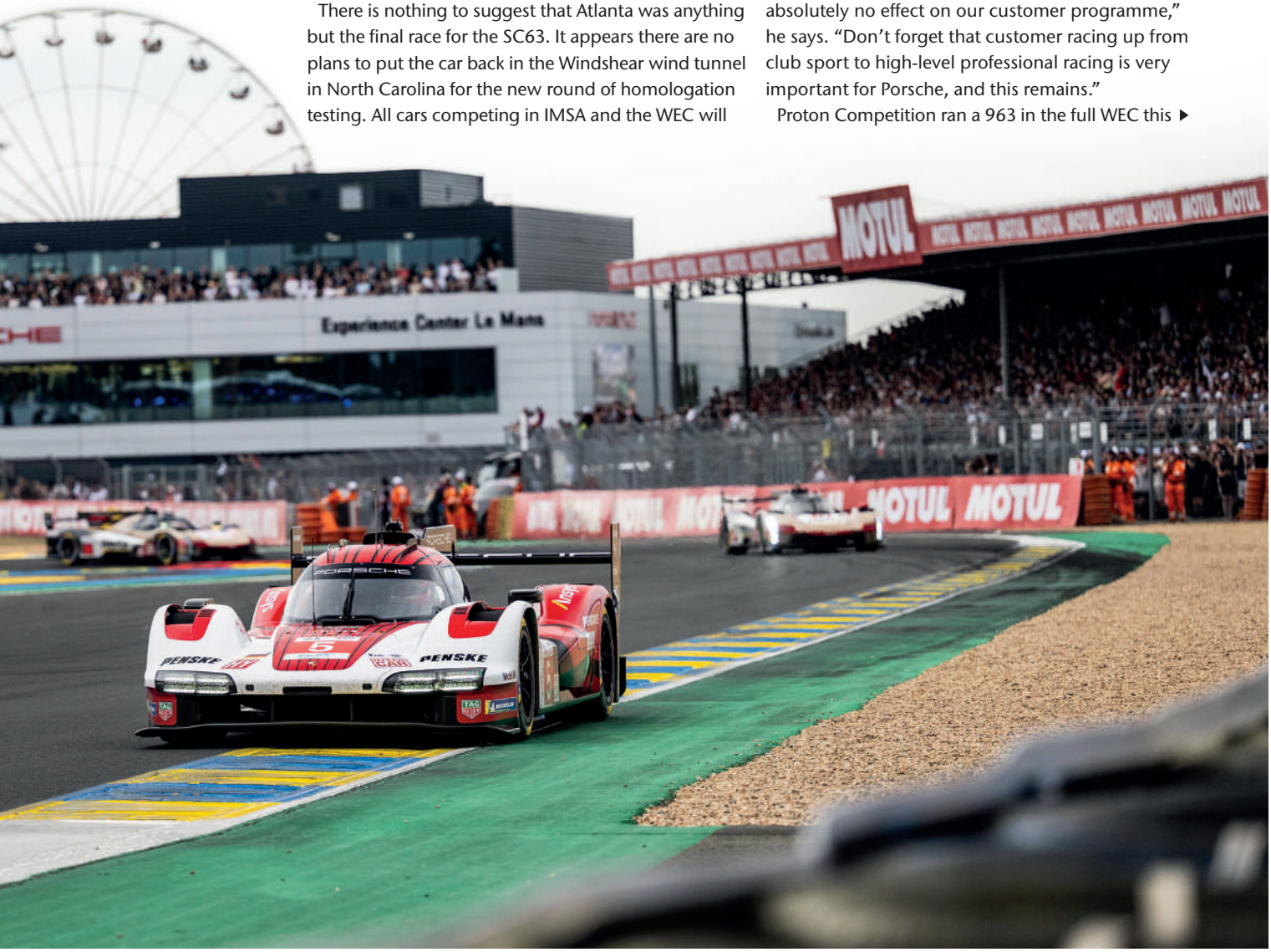
What happens next for Porsche?

The German manufacturer will race on in IMSA with two PPM 963s. It will again be represented in GTP by the privateer JDC-Miller MotorSports squad: the Minnesota-based team was on the full-season entry list revealed at Petit.

Porsche pledged to make its LMDh available to privateers from the get-go. After all, it was named in tribute to the 962, a car that raced in the hands of the official Holbert Racing team and customers from its maiden year in IMSA in 1984. Laudenbach insists there will be no change.

"The only thing I can say is that the decision not to participate in 2026 with our factory programme has absolutely no effect on our customer programme," he says. "Don't forget that customer racing up from club sport to high-level professional racing is very important for Porsche, and this remains."

Proton Competition ran a 963 in the full WEC this ▶



Fabrizio Boldoni/DPPI

BELOW Porsche has pledged to keep making its 963 LMDh available to privateers even once its factory assault ends at the end of 2025

year after blooding its first chassis in the series post-Le Mans in 2023, joining the British Jota squad. Jota ran a solo car from Spa onwards then expanded to two cars last season before landing a deal to become Cadillac's factory representative in 2025. Proton has two chassis: it has run a car in IMSA too, an entry for the enduros this year ending two races early after a shunt at Watkins Glen in June.

The German team has been on the reserve list of Le Mans for the past two years with its second car and it has aspirations to expand for 2026: it is known to be working on a deal to partner with another operation to facilitate that.

What is unclear is whether Porsche needs to have two customer cars on the grid if it is to maintain a presence in the WEC with the 963. The rules as they stand suggest that they do, though they were clearly written for a scenario where the OEM is racing with a factory team and competing for manufacturers' world championship points with any privateers scoring in the FIA World Cup for Hypercar Teams' classifications. There is also a fee for a manufacturer that comes with competing in Hypercar that is over €500,000.

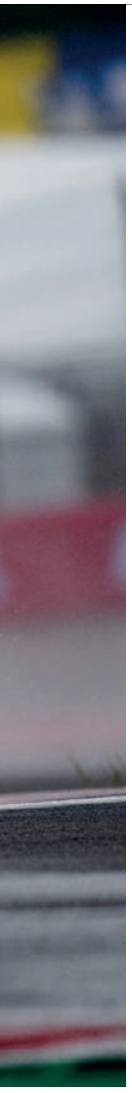
> *"Laudenbach stresses that Porsche remains committed to endurance racing"*

When asked about this, Laudenbach dodges the question, reiterating his point that the WEC decision does not impact its customer programme. Yet he did hint that the question really needs to be put to the series organisers. "You are asking the wrong person," he says. "If a customer wants to race, that's not up to us." But he added: "Why shouldn't we continue the way it is?"

Laudenbach stresses that the decision to leave the WEC is a fresh one and how its wider impact shakes out remains unknown for the moment. That includes whether PPM could be at Le Mans next year. It has in theory won an automatic entry for the centrepiece WEC round in June. One of the three entries IMSA is allowed to award at its discretion has traditionally gone to the winner of the GTP teams' title. "It is not a topic for right now," says Laudenbach of the Le Mans entry. "This is something we will have to look at later on. There are too many question marks."

One of those has to be whether Porsche and Penske would want to go to Le Mans with a single car. For the past three years it has gone with three: it got the IMSA entry last year and exploited the rules that allow Hypercar manufacturers to run an extra car or cars in 2023.

Another possibility is that Porsche could help Proton expand its entry and bolster its assault, perhaps with the loan of factory drivers and engineering support. It would not be without precedent. Back in 2016, Porsche and its Manthey factory team took a year out from the GTE Pro class while it was developing the mid-engined 911 RSR. Proton fielded a solo 911 GT3-R with a line-up of works drivers in its place.



Could Porsche soon be back in WEC?

Laudenbach, again, insists it's too early to talk about that. He does, however, stress that Porsche remains committed to endurance racing. "What we have done is made an adjustment on our factory programmes," he says. "That does not mean we have completely changed our philosophy and strategy.

"We cannot exclude that one day we will come back. If the day comes when we think it is feasible to come back, we will discuss it." Porsche's motorsport boss isn't more specific than that. He chooses not to answer whether 2030 – when there is expected to be a realignment of the rules within the Hypercar division – would be an obvious time to return.

But Porsche has been one of the manufacturers leading the push towards more commonality between the LMDh and LMH rulesets. Laudenbach, again speaking at the Austin WEC round, stressed that it was both desirable and feasible. What appears to be on the table is a move towards the LMDh regulations, but one that allows more freedom for manufacturers. What seems to be being discussed is the possibility for an OEM being able to develop its own chassis rather than being forced to base its car on the spine provided by one of the four licensed constructors, ORECA Motorsport, Dallara Automobili, Multimatic Motorsports and Ligier Automotive. Or to make its own battery and Motor Generator Unit rather than using the off-the-shelf LMDh kit provided by Bosch Motorsport, Fortescue Zero (formerly Williams Advanced Engineering) and Xtrac. The former would be demanded by the likes of Ferrari, which insists a Ferrari can't be built on the same chassis as a Cadillac or a Porsche; the latter by Toyota, which needs to be able to produce its own hybrid tech for what has always been a programme led on its benefits in terms of research and development rather than marketing value.

"This is absolutely possible," said Laudenbach. "I think there is a solution for that. I fully accept a manufacturer saying 'this is important to me': everything I have heard so far can be solved. I am not saying it is easy, but I am pretty sure this is possible."

On the chassis question, he added: "If I want to do my own within the rules of LMDh, where's the problem? I don't see a problem." And on the hybrid conundrum: "If somebody says to me it is the most important thing that the hybrid system is my own, that's fine. You just have to make a technical description of what is allowed."

The drive to bring these regulations together appears to have wide support. Andreas Roos – head of motorsport at BMW, another marque in the LMDh camp – offers a similar opinion. "I don't think it is a problem to have your own chassis or hybrid system," he says. "We need to be clever and make the technical regulations in a certain way so no one has an advantage and the basic technical regulations are the same for everyone. For me this is possible."

Julien Delfosse/DPPI

ABOVE The Porsche Penske Motorsport 963 LMDh has kept winning at WEC's highest level, here topping the podium at September's Lone Star Le Mans in Austin

RIGHT Porsche Motorsport vice-president Thomas Laudenbach insists endurance racing is part of the German company's blood so a return can't be ruled out

Porsche/Michael Kunkel

The first meeting to discuss the idea came during September at Charles de Gaulle Airport in Paris. The manufacturers are under instruction not to talk about what was decided or even discussed. But it can be said that a proposal to shift wholesale to the LMDh platform was thrown out along with any moves to try to introduce changes before 2030. A call from one manufacturer, almost certainly Ferrari, to do away with the BoP as early as next year was also shouted down.

Hypercar rules OK?

The 2030 date is significant. The FIA and ACO have made announcements about the future of Hypercar at Le Mans at each of the past two editions. In 2024, the homologation of the existing cars was extended by two years until the end of 2029. This year, the life of the class – as distinct from the cars – was prolonged by another three years through to 2032. That is where the push to somehow align the two rulebooks comes from.

Laudenbach suggested in Austin that the earlier the better for some kind of convergence. Other manufacturers appeared to agree. It is unlikely that the decision to stick with the status quo for another four years influenced Porsche's decision to end its WEC participation and continue in IMSA. It seems that the axe was at least hovering over WEC, even if it had not fallen.

Porsche didn't shoot for outright glory at Le Mans between 1998 and victory number 16 with the 911 GT1-98 and the arrival of the 919 Hybrid in 2014. Yet after it bowed out of LMP1 in WEC after a hat-trick of wins at the French enduro in 2015-17, it was back after only five years away with its LMDh. So it's anyone's guess how long we will have to wait for victory number 20 for Porsche on the Circuit de la Sarthe. RT

NEW PRODUCTS FOR 2026

A snapshot of the innovations due to be unveiled during show season. By **Mark Skewis**

THE PMW Expo returns to Cologne, Germany, on 12–13 November 2025, signalling the start of the new show season for many motorsport engineers, suppliers and decision-makers.

This year's event pushes deeper into hands-on education, introducing three new, four-hour specialist masterclasses to complement the core exhibition and presentation programme.

The Simulation and Transient Handling Analysis in Motorsport session is led by Javier Bermejo and Alex Burg of Racetrack Dynamics. Design of Springs for Race Cars is run by vehicle dynamics specialist Ton Serné. Tyre Modelling and Simulation for Performance Prediction and Optimization is taught by Prof. George Mavros of Loughborough University.

Here's a sneak preview of some of the companies' wares that will be on show in the main exhibition.

Professional driving simulator software

AVL List

AVL Racetech will present AVL go_RACE, a new professional driving simulator software, at the expo. This tool aims to provide motorsport teams and drivers with accessible, cutting-edge vehicle dynamics simulation. It combines technical precision, realistic vehicle modelling and racing-specific setups in a solution designed for those who demand more than gaming platforms can offer.

In modern motorsport, simulations and virtual methods are an essential part of vehicle concepts, development, setup and race preparation. Staying competitive requires testing before the tyres of the race car even touch the track – digitally, data driven and reproducible. Until now, this approach has largely been reserved for top-tier teams and companies with high-end simulators and complex simulation software.

In today's increasingly professional motorsport landscape, many teams still rely on recognised sim racing platforms. Those tools are primarily designed for online competition and used currently for familiarisation with the racetrack but not for engineering-grade vehicle and driver skills development.

AVL go_RACE is a new software solution specifically designed for professional but cost-conscious racing teams. Based on the high-level AVL VSM Race dynamic simulation platform, the new product takes a streamlined approach, offering accurate vehicle simulation, realistic models and engineering-grade functionality at a significantly lower operating cost.

Part inventory screening for additive manufacturing feasibility

3D Spark

THE 3D Spark platform – on display at PMW Expo – enables component manufacturers to instantly identify which parts in their inventory are best suited for additive manufacturing (AM), with a focus on reducing costs, improving lead times and performance, and uncovering additional design advantages. By rapidly

screening CAD models, ERP data and/or 2D drawings, the platform evaluates the technical feasibility of producing parts through AM, as well as the economic feasibility, lead-time savings and CO_2 footprint reduction that could be achieved. It helps identify AM-suitable components where redesign for lighter, consolidated structures may be possible, unlocking performance and efficiency gains.

This rapid, data-driven analysis eliminates lengthy manual reviews and pinpoints high-impact opportunities for localised, on-demand production. Following the part screening, users can assess whether in-house AM production or outsourcing to qualified suppliers offers the greatest value. This integrated approach shortens lead times, reduces manufacturing and assembly costs and strengthens supply chain agility for spare and replacement parts in the motorsport sector.

Race radio for improved team communication

Autotel

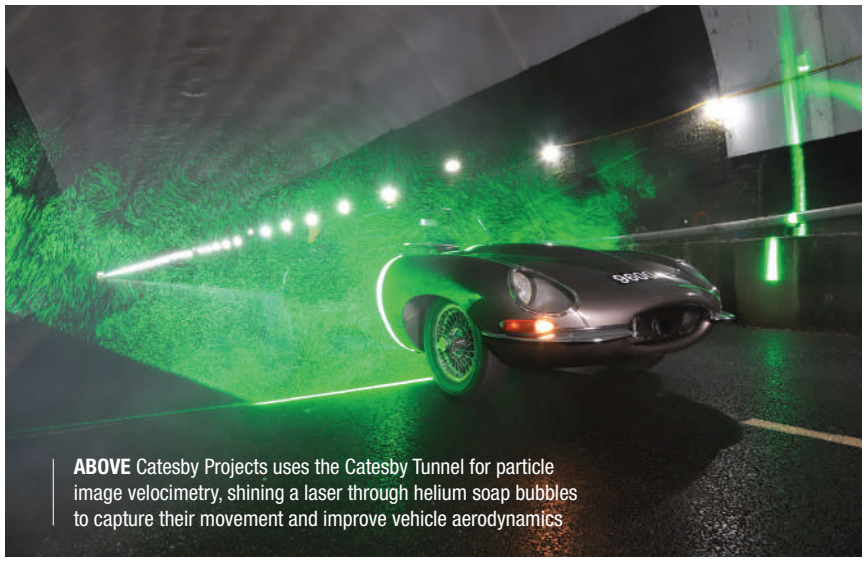
AUTOTEL manufactures and supplies high-quality communication systems for use in motorsport. It offers solutions using conventional radio, press-to-talk over cellular and full duplex wireless DECT intercoms. The company's products include a 4G and 5G advanced PTT-over-cellular

ABOVE Autotel's Race 570 System (pictured) uses PTT-over-Cellular technology to give licence free Race Communications, ideal for circuit use or long range applications

(PoC) race communications system, which is highly flexible and can work for teams of any size, with an unlimited number of communication channels available. It also offers a wireless in-pit intercom system giving full duplex communications on three channels and interface to a radio or PoC link to the race car. The system can run alongside a conventional radio system to give greatly improved team communication in high-noise environments. Find out more in Cologne.

Innovative PIV aero testing
Catesby Projects

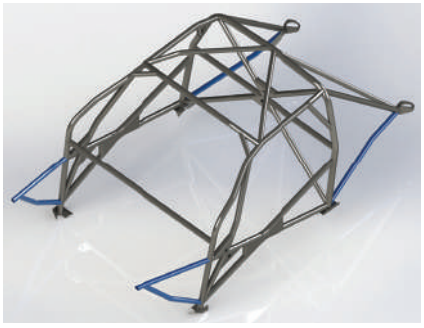
PIV (particle image velocimetry) is not a new technique for understanding the aerodynamic drag of a vehicle, but deploying it in the repeatable environment of Catesby Tunnel is. This groundbreaking application involves seeding the test section with neutrally buoyant helium soap bubbles, shining a powerful laser through them and capturing the movement via multiple high-speed cameras. Improving the aerodynamics of a vehicle in this novel way paves the way for improving the range of EVs and reducing the size and weight of batteries, which is crucial for the decarbonisation of the automotive industry. In motorsport, the possibilities to improve performance are endless. Minor changes in setup, bodywork panels and even wheels can be scrutinised with greater confidence than ever before. Find out more from the Catesby team at the expo.



ABOVE Catesby Projects uses the Catesby Tunnel for particle image velocimetry, shining a laser through helium soap bubbles to capture their movement and improve vehicle aerodynamics

Lightweight FIA-certified roll cage
Custom Cages

BUILDING on the success of its Toyota GR roll cage line-up, Custom Cages will introduce its latest innovation for the GR86 platform at the expo. The lightweight T45 roll cage is engineered for optimised weight and fitment, with optional tube configurations to suit



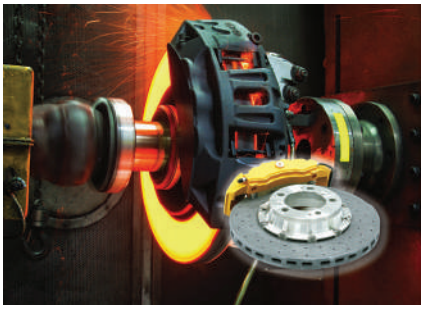
disciplines including rally, circuit, drift and track, making it a truly global solution for competitive motorsport.

Key features include FIA certification for international competition use; lightweight T45 tubing, sourced from top-tier European mills; and optimised safety and fitment through advanced FEA (finite element analysis) testing.

With its full in-house capabilities, Custom Cages can deliver a tailored solution for specific models, from concept and design through to production and certification.

Next-generation carbon-ceramic brake disc with integrated friction surface
DACC Carbon

AT the expo, DACC Carbon will introduce its next-generation carbon-ceramic brake disc with an integrated friction surface, ▶



engineered to eliminate a critical flaw found in conventional ceramic discs: friction surface delamination.

This widespread issue – common in ceramic discs distributed worldwide – is primarily caused by saltwater exposure from winter road de-icing agents. The infiltration of saltwater gradually weakens the bonded interface between the disc body and the friction surface, ultimately leading to delamination, which compromises braking performance and structural integrity.

DACC Carbon's innovative solution eliminates bonding between surfaces by structurally integrating the friction layer directly into the disc body. This integration has been thoroughly validated through rigorous testing with multiple global automotive development teams, and has shown exceptional resistance to thermal fatigue, corrosion and environmental stress.

With this groundbreaking design, DACC Carbon delivers enhanced durability, superior reliability and long-term safety in the most demanding driving conditions.

Double-action hydraulic jack for rally competitions

EVO Corse

EVOJACK Pro is the new double-action hydraulic jack developed by EVO Corse to meet the most demanding needs of rally competitions. Manufactured from aerospace-grade AL6082 aluminium alloy, it combines lightness, strength and functionality in a design engineered for professional use.

Its key innovation is the double-action system, which lifts the vehicle on the downstroke and the upstroke. This significantly reduces lifting time compared with traditional jacks, ensuring greater speed and efficiency during special stages.

Weighing only 4.1kg, with a lifting capacity of up to 600kg and a height-adjustable stand machined from a single solid aluminium block, Evojack Pro delivers reliability and performance under the toughest race conditions. See it for yourself at the expo.

Smart tyre gauges

Fastmate Racing

ACCURATE, professional RaceSense tyre gauges save pressure and temperature data automatically and sync to cell phones. PMW Expo visitors can find out about the benefits of these smart tyre gauges, which include precision pressure measurement (better than 0.1psi), a rugged metal design, quick two- or four-tyre modes, automatic sensing of weather conditions and location, stealth mode for secret readings, seven presets for different vehicles (professional model only) and a PC setup tool. The gauges work with iPhone and Android.

Professional and handy pocket models are available, with several types of fast-response temperature probes for any application and wheel arch.

RaceSense tyre gauges are used by Pirelli, Michelin, Goodyear, NASCAR, IndyCar, F1, Le Mans 24 Hours, WRC, WTC, superbikes and many other series worldwide.

BELOW Ferodo Racing's new TL163 compound brake pad material has been engineered to maximise rear-axle performance, offering enhanced control and balance under braking

Motorsport brake pads

Ferodo Racing

FERODO Racing has developed and launched a new brake pad material specifically designed for rear-axle motorsport applications. The TL163 compound has been engineered to maximise rear-axle performance while helping to reduce lock-ups, offering enhanced control and balance under braking.

In addition to TL163, 2025 has seen the expansion of Ferodo's front-pad line-up with the introduction of two new compounds: TL180 and TL219. These materials are designed to meet the evolving demands of motorsport teams, providing increased performance options tailored to different vehicle setups and track conditions. Find out more at the expo.

Integrated electric drive units for EV powertrain efficiency

Helix

HELIX will showcase its breakthrough integrated EDUs at PMW Expo 2025, demonstrating how consolidating motors, power electronics and transmissions into single plug-and-play units is transforming EV manufacturing economics.

The company's EDUs deliver exceptional power-to-weight ratios exceeding 23kW/kg with no thermal fade, proven in Formula 1, Formula E and record-breaking applications including the VW ID.R's Pikes Peak victory. By integrating powertrain ▶

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5x 20A channels with adjustable outputs and configurable inputs.
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PDM-4C
4x 20A channels with adjustable outputs and configurable inputs plus CAN Bus connectivity.
12 pin Deutsch DT connection.

POWER DISTRIBUTION MODULES

The new 'mini' Power Distribution Modules from CARTEK have been designed to replace fuses and relays therefore simplifying the vehicles wiring. These 'mini' Power Distribution Modules can be used as expansion units for larger PDM installations or as independent, standalone units.

- Small, lightweight, robust design – just 110g. Fully sealed from water and dirt and highly resistant to shock and vibration.
- Easy configuration is via an integrated pushbutton on PDM – no laptop required.
- Over-Current protection can be configured in 5A steps (20A max) per channel. Selectable 'Soft Start' for driving devices with high inrush such as fans or pumps.
- Control inputs can be configured for high or low level signal activation, rising or falling edge triggers, or PWM input signals (200hz max).
- **PDM-5** can be configured to become a dedicated Headlight or Spot Lamp controller.
- **PDM-4C** incorporates CAN Bus connectivity for transmitting diagnostic data including output status, volts, amps, configuration settings, etc. Outputs can also be controlled through CAN Bus.

SOLID STATE BATTERY ISOLATORS

Following on from their highly popular GT & XR Battery Isolators, CARTEK have introduced two new versions: *X-CLUB* & *X-PRO*.

These new versions have been designed to be more cost effective with greater performance and diagnostic features and suited to all levels of motorsport from grassroots to top tier.

BATTERY ISOLATOR X-CLUB
Low cost version designed for cars 4-6 cylinder.
Ideal for one-make championships

BATTERY ISOLATOR X-PRO
Designed for high performance vehicles.
Fitted with Deutsch DT connector

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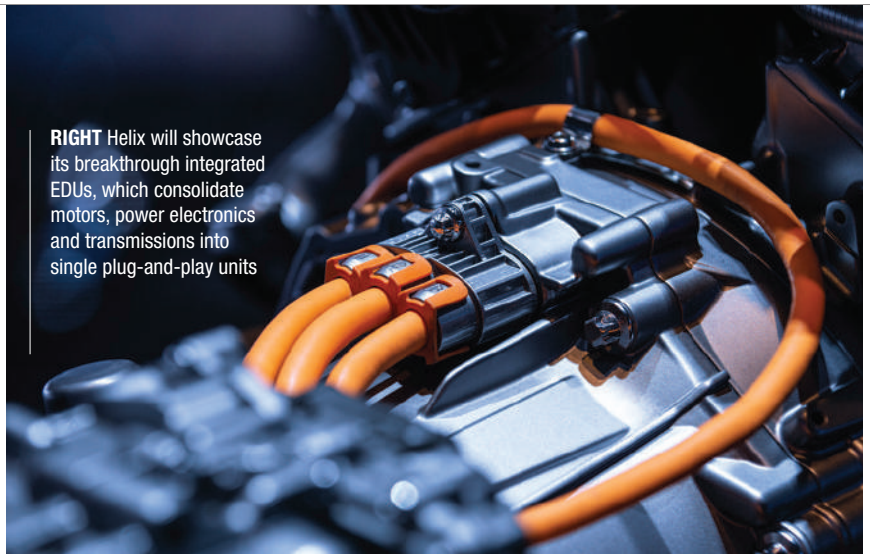


RIGHT Helix will showcase its breakthrough integrated EDUs, which consolidate motors, power electronics and transmissions into single plug-and-play units

components into unified systems, EDUs reduce assembly complexity, cut costs by an order of magnitude for high-performance applications, and enable optimal component matching for superior efficiency.

Key innovations on display at the expo will include Helix's Scalable Core Technology platforms (SPC177, 242 and 330), advanced thermal management solutions and the CTI-4 800V silicon carbide inverter designed for the extreme demands of motorsport. The company's X-Division will present bespoke powertrain solutions featuring Scalable Integrated Motor and Inverter (SIMI) technology.

Visitors will discover how EDUs are enabling auto makers to reduce the 51% powertrain cost burden in EVs while achieving the space efficiency and performance margins critical for next-generation electric vehicles across motorsport and automotive applications.

Next-level diesel turbo innovation

HP Turbo

HPTURBO will be at PMW Expo to show its GTD35-900VR, which offers high-performance diesel turbocharging.

Developed as a conversion from G to GTD technology, it was designed primarily for the legendary 1.9 TDI platform, but with modular construction that makes it adaptable far beyond its original application – including BMW performance setups and 4x4 projects.

Key features include a CNC-machined compressor housing with an MFS billet wheel for faster spool, a high-flow turbine for maximum efficiency, and the option of a high-flow exhaust upgrade. The GTD35-900VR is also available with a BMW F10-style compressor housing and manifold, extending compatibility even further.

With proven performance exceeding 500hp, this turbo combines OEM-level reliability with motorsport-grade power. There is also a version with a fully modular electronic rotary actuator, allowing multiple installation positions for excellent flexibility.

Racing scales and race-car alignment tools

Intercomp

INTERCOMP is a world-leading manufacturer of accurate, reliable wireless race-car scales and measurement devices, including the advanced RFX wireless weighing technology scale systems, chassis setup equipment, auto alignment devices and test equipment. Representatives from the company will be at the expo with some of the latest products.

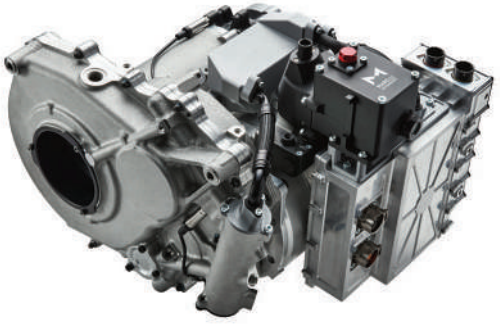
All the products are assembled in the company's US facility. The RFX wireless weighing technology is recognised by customers as being among the most reliable wireless racing scales on the market.

Electric axle for elite racing performance and efficiency

Marelli

THE REA (Racing Electrical Axle) – which will be on display at the expo – is a cutting-edge, fully electric axle designed for elite racing applications. This ultra-compact assembly integrates the following subsystems: a direct oil-cooled MGU (motor generator unit); an MCU (motor control unit); a GBX reducer; and a cooling system.

The MGU is a high-speed, three-phase synchronous machine with permanent magnets, using direct oil-cooling technology. This system, complemented by a high-performance rotor array and ultra-thin stator steel lamination, achieves remarkable power density, making it ideal for racing and heavy-duty applications. The MCU functions as a bidirectional AC-DC power converter, capable of driving the three-phase MGU. Its power stage is founded on a proprietary two-level full SIC MOSFET power module, incorporating the patented EDI (Enhanced Direct-cooling Inverter) power module cooling technology. The control section is outfitted with advanced hardware and software resources to ensure high-efficiency motor drive.



The GBX system features a high-efficiency, single-ratio oil-lubricated reducer, paired with a hydraulic active differential that actively modulates locking torque.

Heat management is handled by an active cooling system, efficiently dissipating heat through a main water-cooled setup directly connected to the car's radiator.

This innovative blend of electrification technologies underscores a commitment by Marelli to excellence in high-end motorsport applications. ▶

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High-frequency telemetry analysis
Marple BV

MARPLE delivers a powerful duo for teams working with high-frequency telemetry: Marple DB for smart data storage, and Marple Insight for fast, engineer-focused analysis.

Marple DB is an alternative to traditional time series databases. Built specifically for high-ingestion telemetry data, it offers efficient storage, fast querying and streamlined organisation of large datasets. Whether users are logging from test benches, track sessions or prototypes, Marple DB handles the volume without compromising performance.

Marple Insight connects directly to Marple DB or to users' existing infrastructure. It gives engineers the ability to visualise and analyse structured time series data with powerful dashboards, custom metrics, fault detection and real-time collaboration.

Used together or independently, Marple DB and Insight reduce time-to-insight and simplify how telemetry is used across teams. At the expo, the company will demonstrate how engineers can go from raw data to actionable insight in seconds, on and off the track.

IPC training for high-performance, high-reliability motorsport electronics
Marq-One

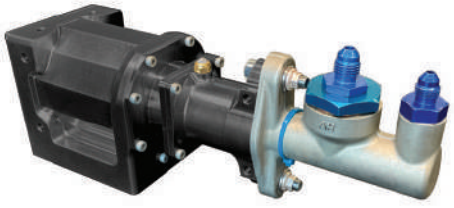
MARQ-ONE will showcase its IPC training programs tailored for high-performance, high-reliability electronics that must survive the extreme conditions of motorsport. From the intense heat generated to the relentless vibration and g-forces endured lap after lap, the electronics and wiring harnesses in race cars must perform flawlessly, every time.

The training programs are built around internationally recognised IPC standards, ensuring that every delegate gains the skills and knowledge to design, build and maintain electronics that can survive and excel in such harsh environments.

They support the full spectrum of the industry, from elite race teams to specialist suppliers, helping them meet and exceed these demanding standards. By embedding these best practices, Marq-One enables clients to deliver components that withstand the rigours of racing while maintaining peak performance and reliability.

Whether it's a critical wiring harness or mission-essential control electronics, the IPC training ensures each team is ready for the toughest environments in motorsport.

Next-generation e-clutch actuator
Mega-Line



MEGA-LINE racing technology (formerly Mega-Line Racing Electronic) will introduce its next generation e-clutch actuator at the expo. This latest evolution of the company's clutch-by-wire actuator has been designed and developed with a focus on increased durability paired with significantly faster actuation speed (full clutch travel <100ms). This builds on the absolute precision of actuation established with the previous generations of e-clutch actuators. The combination of speed capability and durability means the actuator can be employed beyond simple car launch. The increased actuation speed caters for demanding anti-stall scenarios, and the improved durability allows greater frequency of clutch use than just pulling away from pitstops, such as clutched shifting in motorsport or in combination with H-pattern gearboxes in historic cars.

The e-clutch actuator will be available as a plain actuator and also combined with the proven Mega-Line standalone marshal disconnect functionality to comply with FIA safety regulations for external drivetrain disconnect, enforced in various categories such as GT3, Hypercar, LMDh and more.

Integrated metal additive manufacturing solutions
Nikon SLM Solutions

NIKON SLM Solutions is a global provider of integrated metal additive manufacturing solutions, and some of these will be on display at the expo. The company is home to what are reported to be the world's fastest metal additive manufacturing machines, boasting up to 12 lasers and enabling build rates of up to 1,000ccm/h. With a portfolio of systems to suit every customer's needs, along with its team of experts closely collaborating at every stage of the process, Nikon SLM Solutions aims to lead the way on return on investment with maximum efficiency, productivity and profitability.

Friction/stiction-free high-performance suspension mounting bushes
Powerflex

POWERFLEX is launching a new range of innovative suspension bushes for the McLaren range of cars. These kits replace the original rubber bushes and are designed to be pressed into the OE wishbones. They completely eliminate all friction using a PTFE bearing assembled inside the bush to act on the 316 stainless-steel centre sleeve. This bearing is encapsulated in shore A92 polyurethane to ensure good chassis isolation and retaining compliance. There are two specifications of these kits, including a lightweight version that saves over 2kg compared with the total weight of the OE bushes. Although they are specifically designed for the McLaren range, they can be custom manufactured to drawings in a similar specification.

World-class cooling technology
PWR

PWR is a global designer, manufacturer and supplier of technically advanced high-performance cooling solutions, investing in research and development to provide solutions using advanced cooling technology. The company adopts a flexible manufacturing approach and works in technical partnership with customers from a diverse range of industries. ▶

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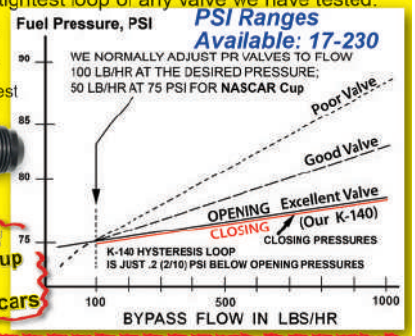

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EFI Injectors, all makes of Pressure Relief Valves and Lucas Mechanical Metering Units, need 3 micron protection, but 3 micron filters plug up too quickly, so most racers use10 micron, which is too coarse. We made this new element for NASCAR Cup cars: 10 micron premium paper top layer to take out 95% of the dirt, with a 3 micron precision Fiberglass lower layer. Details: Kinsler.com

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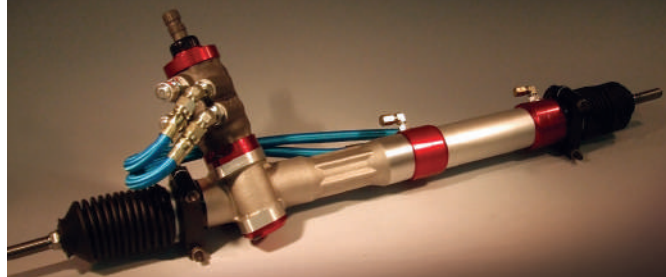

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for left or right hand drive, front or rear steer,
with a choice of three pinion angles,
three piston sizes, seven gear ratios,
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Extensive experience and years of research and development have led to PWR being a global leader in tube and fin and bar and plate heat exchangers. The firm can also completely customise not only the size of the cooler but the shape as well. With the ability to produce 2D-profiled coolers and free-form coolers, PWR can design a tube fin cooler to maximise heat exchanger face area and minimise packaging space.

PWR is also a leader in liquid cold plates, and offers compact Micro Matrix Heat Exchangers (MMX), which provide efficient cooling performance. Find out more at the expo.

Specialist servohydraulic mechanical simulation and test systems
Servotest

SERVOTEST is a UK-based supplier of specialist servohydraulic mechanical simulation and test systems. Using low-friction hydrostatic bearing actuators, optimised for dynamic performance with long service life, it delivers innovative, cost-effective systems tailored to customers' needs.

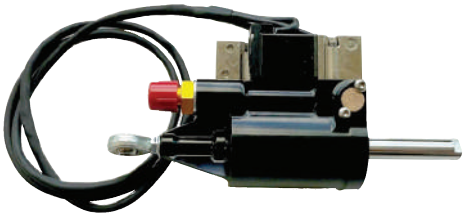
Pulsar controls combine a robust distributed architecture with fibre-optic digital communication. EZFlow test sequencing and customised displays support expert or novice users alike.

For motorsport, there are significant benefits for trackside testing, as expo visitors can discover. Fine-tuning of a vehicle's dampers and suspension by the track brings major improvements in vehicle performance. Servotest has developed a mobile damper tester to meet these new testing challenges in the motorsport industry.

The Servotest design delivers benefits in performance and energy efficiency over conventional damper testing machine designs. It fits in a standard truck trailer and has been configured to minimise power consumption. The system can be run from solar panels installed on the truck's roof.

Versatile pneumatic control
Shiftec

BASED on proven pneumatic technology, Shiftec's latest DRS actuator, specifically designed for the 2025 MSV GB3 single-seater championship, seamlessly integrates with the current mounting hardware and rear-wing swan neck.



This version offers the following features: maximum force of <800N; maximum stroke of 28mm; maximum operating pressure of <10 bar; 12V valve actuation; 5V integrated position sensor; fully MS wiring terminated with Deutsch AS107-35PN; five-axis machined CNC aluminium housing; weight of 380g.

The versatile Shiftec DRS pairs easily with the company's pneumatic gear-change solutions. Driven by one billet compressor, it is a compact, lightweight, cost-effective solution. Find out more at the expo.

High-performance alloy wheels
Dyn Automotive

DYN AUTOMOTIVE will exhibit race-proven, super-light Team Dynamics Pro Race alloy wheels in cast, flow-formed and forged derivatives. New sizes and options are available in the Pro Race 1.2 and LT ranges for modern motorsport and street users looking for a high-performance option.

In addition, the growing Classic Heritage Race wheel range caters for Lotus Cortina, Lotus Elan, Ford Mustang and Porsche 911, and a niche special order facility is now available.

As well as the renowned Team Dynamics ranges, Dyn Automotive offers full technical design, testing and production for customers who need a complete white label service.

Dyn Automotive is a supplier to the British Touring Car and Australian Supercar championships.

High-performance turbochargers
Van Der Lee

EXPO visitors will be able to see Van Der Lee Turbo Systems' new range of lightweight, high-performance turbochargers, which is aimed at professional motorsport and extreme performance applications. It draws on the company's experience with the Porsche 963 and Alpine LMDH endurance racing programs and its work on the development of Formula 1 turbochargers with a power unit manufacturer for the upcoming 2026 regulations.

The new turbos accommodate power levels from 250bhp to 1,050bhp. Each turbocharger features a nickel-based superalloy turbine wheel, a stainless-steel turbine housing, a fully machined compressor wheel made from aluminium or titanium, a dual-row ceramic ball-bearing system, and a one-piece fully machined lightweight compressor housing.

The turbochargers are suited to a wide range of vehicles and engines, from rally and rallycross to GT, single-make series, prototype endurance and touring car applications.

The VD056/VD061/VD068 turbochargers can be configured as direct replacements for existing professional motorsport turbochargers, including a regulation inlet restrictor attachment if required, and turbine housing V-band inlet and outlet connections to suit existing exhaust system designs. These direct replacement units reportedly realise a 25-35% weight reduction and 25-40% cost saving compared with the motorsport turbochargers currently available. Also on show will be the company's innovative microbolometer-based thermal camera system, which it says is the most accurate form of external tyre temperature measurement on the market with accuracy of <1% FS over 240 pixels. The system is available with varying lens options to give a field-of-view of 66° or 113° and the data is output via CAN.

Temperature data can be configured to 4 x 60 pixels or 2 x 70 pixels (other pixel matrix options available on request). New for 2024 is the MIB-S-P – an IP67 waterproof version of the race-proven device. RT

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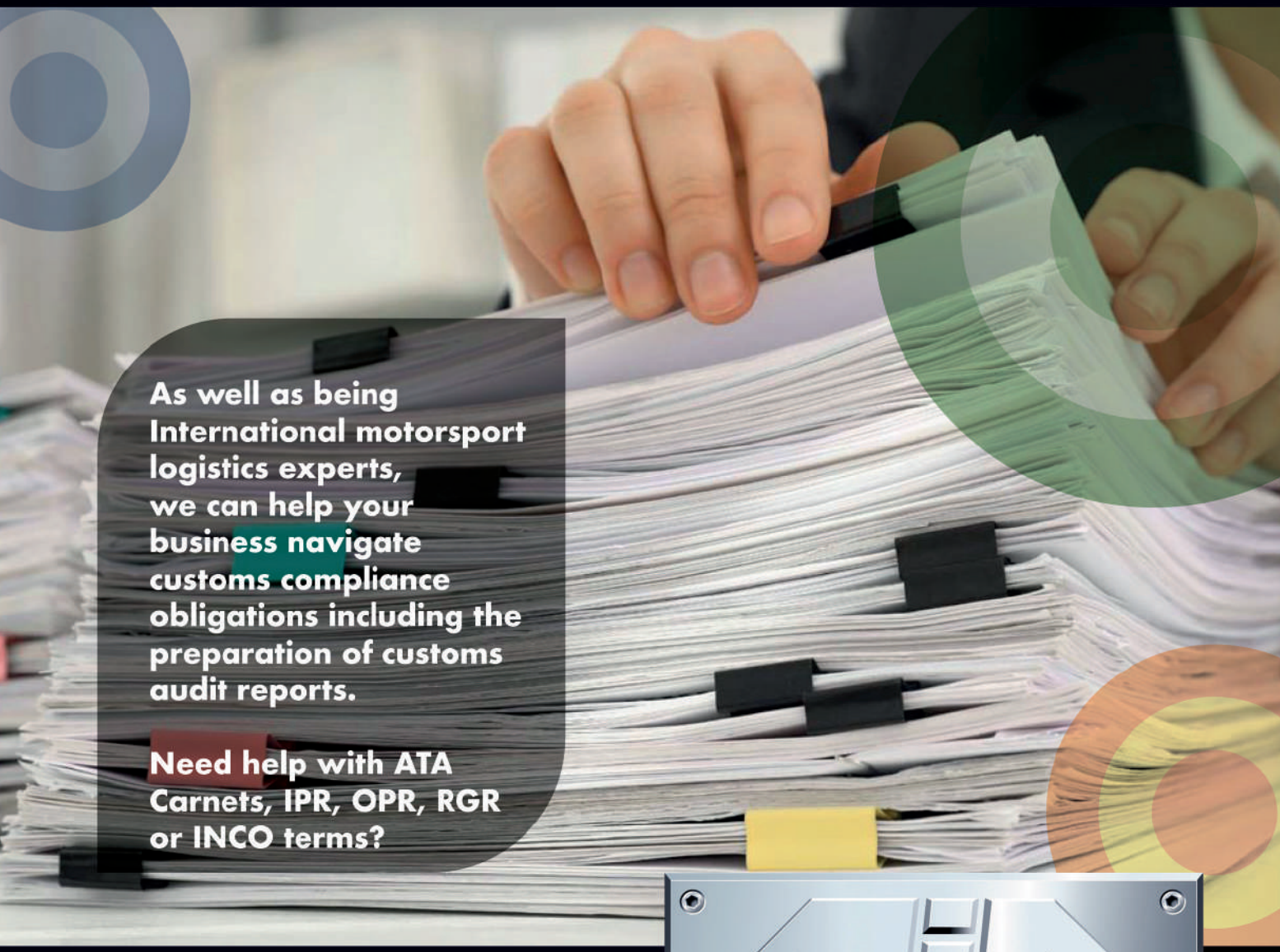

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PROTECTING ENGINE MANUFACTURERS FROM THEMSELVES

Sergio Rinland contemplates the FIA's introduction of a safety net for any F1 manufacturer whose power unit falls short of its rivals' performance. Oh-oh…

A FEW issues ago, we criticised the FIA for overzealously protecting drivers from themselves in the name of safety. Now, it seems the focus has shifted, this time, to protecting engine manufacturers from their own shortcomings.

I've always liked rule changes in motorsport. They offer engineers and designers a chance to create something special, something that gives them that elusive "unfair advantage" (to paraphrase Mark Donohue), the kind that turns underdogs into winners or at least helps them punch above their weight. Remember the old Jordan team?

But under the revolutionary 2026 F1 regulations, any such advantage may last no more than six races. Why? Because the FIA plans to intervene, ensuring that teams who didn't get it right initially receive extra resources to catch up with those who did an exceptional job. The FIA insists this isn't Balance of Performance (BoP). But it's worse, it's akin to a performance-based DRS, all in the name of keeping underperforming OEMs happy (and spending above the budget cap, which they certainly can).

The original intent of the budget cap was to level the playing field, giving all teams equal resources so that talent and ingenuity could shine. Now, talent seems optional. If you're better than your rivals, the system will reward them with extra support to catch up, while you stand still.

That's not what motorsport is supposed to be. Motorsport is, or should be, a pure meritocracy.

It feels like the FIA's right hand doesn't know what the left hand is doing. The F1 technical team should learn from the experience of other technical teams. We all praised the creation of the LMH/LMDh formula, which struck a promising Balance of Technology. But things went pear-shaped when they started meddling with BoP. The result? Two of the most iconic names in prototype racing are deeply unhappy. Porsche is leaving Le Mans, Porsche! And Toyota is shifting focus to hydrogen energy, risking the end of a golden era in prototype racing.

Yes, Mercedes made a massive leap in 2014, leaving the competition in the dust. It took years for others to catch up, and many blamed testing restrictions and rule stability rather than acknowledging the brilliance of Mercedes' engineering. Back then, there were no budget or resource limits. That kind of success is what motorsport is all about, whether you liked it or not.

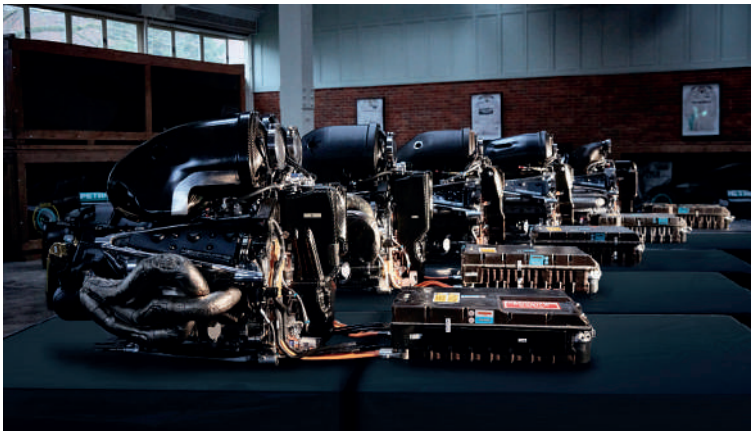
So, what now? Damned if you do, damned if you don't? Should we penalise the talented? I think not.

It seems decision-makers fail to consider the consequences of their actions. Every policy change has ripple effects, in motorsport, politics, and life. The FIA should have thought more carefully about the implications of combining sweeping rule changes with a strict budget cap.

The budget cap is already a limitation to equalise opportunities. Yet motorsport engineers have a knack for outsmarting FIA engineers, even when the latter are former F1 veterans. It's not just about resources; it's about motivation. And the desire to win is more powerful than any regulation.

This echoes the LMH/LMDh situation. Downforce is tightly regulated through wind tunnel testing and instrumentation, and power output is controlled via torque sensors and standardised curves. But human ingenuity always finds a way. So, the FIA and ACO resort to the much-maligned BoP.

As we said two months ago, this kind of interference risks turning motorsport, and F1 in particular, from a great sport into a mere game (to paraphrase Hemingway). RT



BELOW The FIA's decisions have been influenced by Mercedes' domination of the initial years of the hybrid era

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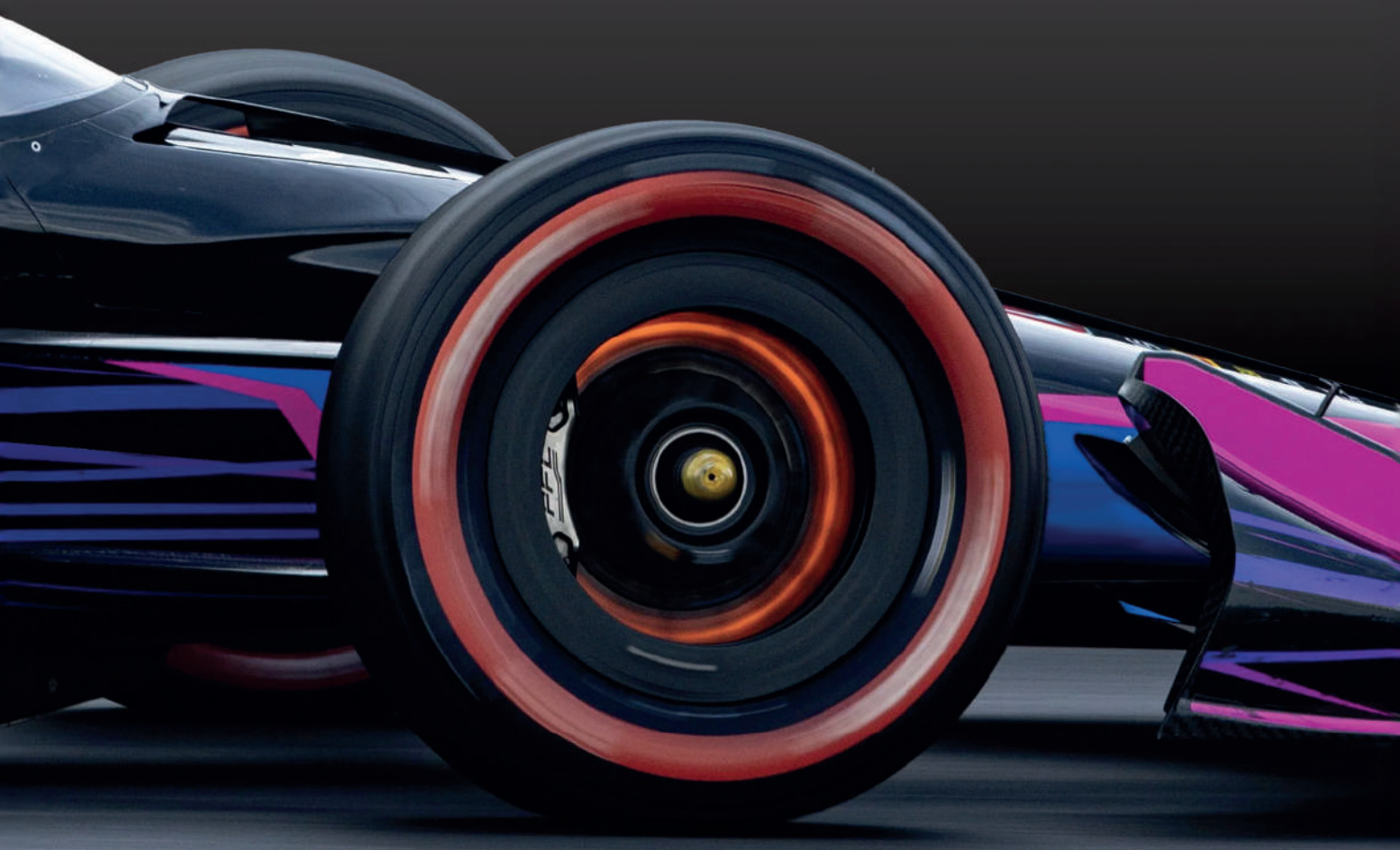

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